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Boosting lysine improves nutritional value of corn

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Cereals provide, directly or indirectly, about 70% of the protein in our diets. Unfortunately, most of the protein they contain is of poor quality – lacking several amino acids essential to human nutrition. Of these, lysine is the most limiting.

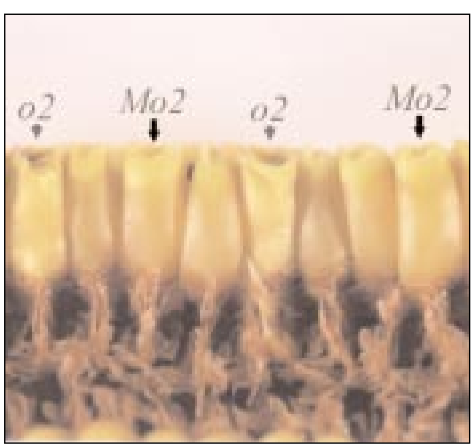
The discovery in the early 1960s that the *opaque2* (*o2*) gene increases the percent of lysine in corn seed prompted a great deal of optimism that this mutation would dramatically improve the nutritional value of this grain.

The euphoria over *o2* was soon tempered, however, by the discovery of persistent side effects of the mutation – a soft endosperm (the part of the seed where most of the protein is stored) that results in damaged kernels, an increased susceptibility to insects and fungal pests, inferior food processing, and generally reduced yields.

By the mid-1970s, no commercially important *o2* corn varieties were being grown in the U.S., nor in developing countries. But plant breeders discovered genes (called "*o2* modifiers") that altered the characteristics of *o2* mutants, overcoming some of the original problems.

By systematically crossing *o2* modifiers into *o2* corn varieties, while simultaneously monitoring the lysine content of the grain, plant breeders at the International Maize and Wheat Improvement Center (CIMMYT) in Mexico developed a new type of high-lysine corn called "Quality Protein Maize" (QPM).

QPM offers great potential to improve human and livestock nutrition in many parts of the world, including Africa, China, and Latin America, and efforts are underway to create new varieties that are suitable for production in these regions.



Ear of *opaque2* corn with kernels showing effects of *o2* modifiers (*Mo2*). While *Mo2* kernels are glassy, like normal (wild type) seeds, *o2* kernels have a dull appearance, indicating a starchy endosperm.

Challenge

Selecting corn varieties for even higher levels of lysine in the kernel is a major

The results imply that selecting varieties with the largest number of small protein bodies will lead to the highest possible lysine content.

challenge of developing QPM to meet the requirement of a nutritionally balanced source of protein for humans and other single-stomach animals.

Humans require 5% lysine in their diet, while *o2* mutants, including most QPMs, typically contain about 3-3.5% lysine. Corn protein normally contains only about 2% lysine.

With support from USDA's National Research Initiative (NRI) Competitive Grants Program, researchers at the University of Arizona have been investigating this problem by characterizing the mechanism by which the *o2* mutation increases the synthesis of lysine-containing proteins in the endosperm.

They discovered that a protein needed by cells to function normally (a protein synthesis factor called eEF1A) is rich in lysine (10%), and its level is doubled in *o2* mutants. They also found a high correlation between the concentration of eEF1A and the total lysine content of the endosperm.

Thus, the mechanism by which *o2* increases the lysine content of the endosperm is a function of increasing eEF1A and other related proteins. This suggests that one can create hybrids with significantly enhanced levels of lysine by selecting corn varieties with a high level of eEF1A.

Impact

The researchers have shown that crosses between plants with high and low amounts of eEF1A produce progeny with varying levels of this protein. This indicates that the high-eEF1A trait has a genetic basis – and that it can be selected by conventional breeding.

The variety with the highest level of eEF1A (lysine) has the largest number of protein bodies, which are smaller than those in the low-eEF1A variety.

In effect, protein bodies in the high-eEF1A variety have a greater surface area, which increases the amount of lysine-containing proteins surrounding them. The results imply that selecting varieties with the largest number of small protein bodies will lead to the highest possible lysine content. This hypothesis will be tested.

In the meantime, laboratories around the world are applying this discovery to improving protein quality in their locally grown corn varieties.

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