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Increasing the Nutritional Quality of Corn

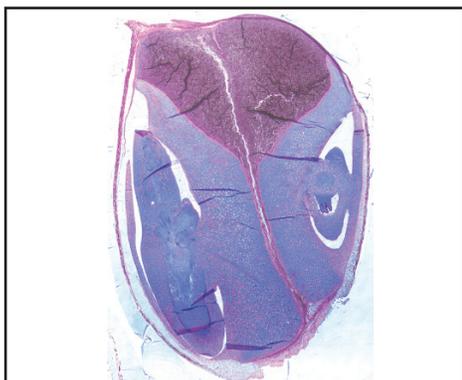
Daniel Gallie, Department of Biochemistry, University of California, Riverside, CA

Cereal grains are the crops most important to human survival, and corn is one of the most valuable cereal grains to U.S. agriculture. Cereals like corn are used to feed much of the world either directly through oil, protein, and starch or indirectly through livestock feed for meat-producing livestock. Since most people in developing countries do not have access to meat as a source of protein, they obtain a high percentage of their total protein intake directly from grains. Protein malnutrition is a leading cause of death among children in developing countries, many of which already produce corn as a major cereal crop. The ability to increase the nutritive value of corn would help reduce childhood protein malnutrition.

Also, population growth is projected to outstrip world food production by mid-century. According to the United Nations' Food and Agriculture Organization, traditional breeding improvements used to make today's higher-yielding grain varieties are unlikely to generate the additional increases in productivity needed in the future. In a field where a 1 percent increase in starch, oil, or protein content is considered a significant achievement, the ability to increase that by 100 percent would be a considerable achievement.

In work funded in part by the USDA's National Research Initiative, biochemist Daniel R. Gallie at the University of California, Riverside worked with a team of researchers to develop technology that doubles the protein and oil content of corn grain. This improvement is the result of an increase in the production of cytokinin, a plant growth hormone, in the flowers of the corn ear. Flowers in the corn ear develop in pairs, but one from each pair normally aborts before pollination. Each flower of the ear that survives goes on to produce one kernel. Because of the role that the plant hormone, cytokinin, plays in preventing

CORN ENGINEERED TO CONTAIN TWO EMBRYOS (STAINED BLUE)



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This new type of corn has the potential to feed the world population, to increase profitability to U.S. farmers, and to provide consumers with a “low-carb” corn.

organ death, the Gallie research team introduced a gene that enabled production of cytokinin in developing flowers. Surprisingly, not only did this hormone rescue flowers from abortion, but the kernels produced from each pair of flowers fused into a single normal-sized kernel that contained two embryos (see photo on previous page), which are the parts of the kernel that develop into a new plant. Two seedlings emerged from a single kernel when planted (see photo below).

Because the embryo contains the majority of protein and oil of the kernel, the presence of two embryos doubles their content in corn grain. The endosperm, which contains most of the starch in corn grain, was also reduced in size. As a result, the corn grain contained less starch, but more protein and oil, resulting in “low-carb” corn.



EMERGENCE OF TWO SEEDLINGS FROM DOUBLE EMBRYO CORN SEED

IMPACT

The findings are important to agriculture because they suggest that the level of cytokinin may determine whether abortion in flowers occurs. This knowledge can be used to modify grain to improve its nutrient and economic value.

The research findings may be beneficial in three ways. First, they provide a useful approach towards the goal of feeding the world population. This new type of corn would provide more protein and oil to those that depend on grain as their primary source of these nutrients. Second, the present technology would also provide an advantage to U.S. farmers in world grain markets. Oil is the most valuable component of corn, and any increase in the amount of oil in corn grain increases its value to U.S. farmers. Third, many people in the U.S. and other first world countries are concerned with consuming excess calories. Interest in low-carbohydrate diets has grown tremendously. Because corn is normally avoided in “low-carb” diets, reducing the starch content while increasing the protein and oil content means this “low-carb” corn may provide the means for people to eat corn and still achieve their dietary goals.

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