

Declining Nutritional Value of Produce Due to High Yield Selective Seed Breeding

by Vicki

February 27, 2007

One look at a big, red tomato and one can almost taste its' juicy freshness...unless, that tomato was part of a group of 43 fruit and vegetable crops analyzed by Dr. Donald Davis, research associate at the Biochemical Institute at the University of Texas, Austin. For two decades, Davis and two colleagues Melvin Epp, and Hugh Riordan analyzed nutritional data taken from selectively bred high yield conventionally grown produce. In 2005, their study titled "Changes in USDA Food Composition Data for 43 Garden Crops, 1950 to 1999" showed the results.

According to Davis, "We tracked 50 years in U.S. Department of Agriculture food composition data for 13 nutrients in 43 garden crops, vegetables, strawberries and three melons. Low and high yield varieties were grown and analyzed side by side eliminating key uncertainties that apply to historical data. The data was then analyzed."

The following information is taken from that paper with editorial changes made to increase its understanding for readers. What the researchers found were declines in average concentrations of six nutrients. The subtraction sign representing the negative symbol, indicates decline. The results of 20 years showed declines in: protein of - 6%, calcium: -16%, phosphorus: - 9%, iron: -15%, riboflavin: - 38%, and vitamin C: - 20%.

In the article, Davis cited direct evidence of genetic trade-offs between yield and mineral concentration in [broccoli](#), between calcium and magnesium, and for wheat, in iron between zinc, copper, selenium, phosphorus, and sulfur. Correlation coefficients between yield and nutrient concentrations were negative for 14 hard red winter wheats. For 27 commercial broccoli hybrids, correlation coefficients between yield and calcium and magnesium ranged from - 0.46 to -0.69.

"There seems little doubt that sizable genetic trade-offs exist, but we do not yet know their breadth," Davis stated in his conclusions.

An explanation of exactly what happens in genetically engineered dilution effects may be helpful. Over many years of using yield potential as the dominant criterion in developing improved varieties, while average yields have risen, plant root systems have not been able to keep pace in drawing more needed micronutrients from the soil. When breeders selectively breed for one resource, using a selected trait like yield, fewer resources remain for other plant functions as the study explains.

"There may be trade-offs between the number of seeds and their size or between yield and growth rate and pest resistance. In [tomatoes](#), there are trade-offs between

yield which is the harvest weight and the dry weight, or between yield or fruit size and vitamin C, and between lycopene which gives tomatoes their the primary color and beta-carotene which is the precursor to vitamin A."

This information on nutritional decline and selective breeding is nothing new to agricultural researchers and scientists. Science journals began publishing writings on nutritional decline over 20 years ago. A 1981 review in "Advances in Agronomy" discussed the widely cited "dilution effect," in which yield-enhancing methods like fertilization and irrigation may decrease nutrient concentrations, an environmental dilution effect. Recently, evidence has emerged that genetically based increases in yield may have the same result, a genetic dilution effect. An explanation of exactly what happens in genetically engineered dilution effects may be helpful. Over many years of using yield potential as the dominant criterion in developing improved varieties, while average yields have risen, plant root systems have not been able to keep pace in drawing more needed micronutrients from the soil. When breeders selectively breed for one resource, using a selected trait like yield, fewer resources remain for other plant functions as the study explains.

Either way, modern crops that grow larger and faster are not necessarily able to acquire nutrients at the same, faster rate, whether by synthesis or from the soil.

In view of all of this, Davis merely contends, "We should not assume that plant composition remains constant as we increase yield."

Farming's bottom line is based on per acre crop yield per harvest. The dry weight of a crop which is the size of a crop, determines its profitability. The yield per acre can increase or decrease based on a variety of factors ranging from weather to pests to soil corrosion or erosion.

When during the 60s' and 70s', major changes in environmental and genetic growing methods came into wide use resulting in higher crop yields, it was seen as an economic boon to farmers especially grain farmers. These methods included fertilization, better irrigation, pest and weed control, increased variety and selective seed breeding. Greatly increased yields of wheat, rice, and maize followed. Little did anyone know that by breeding increased yield, nutritional quality would be compromised. This unintended nutritional side effect was the basis for Davis' study, "Tradeoffs in Agriculture and Nutrition" in March 2005 in "Food Technology".

Chief scientist and sustainable agriculture expert for The Organic Center, Charles Benbrook had this to say about nutritional declines. "Plant breeders could maintain and even increase the nutrient content of most crops. But this goal usually takes a back seat to economic issues," Benbrook said. "Large growers want size and fast growth so they can harvest early. These factors feed into sacrifices in nutritional quality."

Benbrook says farming's dependence upon chemical nitrogen fertilizers means we're getting less for our money.

"Numerous studies have demonstrated that high levels of nitrogen stimulate quick growth and increase crop yields because the fruits and vegetables take up more water. In effect, this means consumers pay more for produce diluted with water. High nitrogen levels make plants grow fast and bulk up with carbohydrates and water. While the fruits these plants produce may be big, they suffer in nutritional quality.

"You can't buy soil quality in a bag any more than you can buy good nutrition in a pill. Unless we understand much more fully what the critical balances are (in natural plants) it's very difficult to import them to the farm in a bag or a bottle." Benbrook said.

The Organic Consumers Association (OCA) is a non-profit that works for fair trade, food safety, organic farming and sustainability. Featured on their website is a Mother Earth News article from 2004. The article documented nutritional declines in meats, poultry, dairy products, fruits and vegetables. The OCA contacted the U.S. Secretary of Agriculture for the official explanation. The secretary was asked if nutritional declines were linked to preventable factors.

The USDA's Agricultural Research Service Director responded on behalf of the Secretary confirming that the nutritional decline findings were true in many, but not all cases. The Director went on to list variables that might be related to these apparent declines but offered no indication that the USDA would be studying the issue further. Recently the same reporters contacted the USDA again to find out any new developments on the matter. The USDA office referred them to their previous response and had no further comment on the subject. Both email and telephone contacts to the USDA were made for this article. No response had been received.

Benbrook has been quoted saying the USDA has a "tacit policy to avoid discussions of differences in food quality and safety that may be a function of how food is grown and processed," Benbrook said. "The Department (USDA) made a political decision when they finalized the national organic rule. They declared that organic food was not nutritionally superior or safer than conventional food, even though there is solid evidence suggesting otherwise. Organic production systems which use slow-release forms of nitrogen produce foods that usually yield denser concentrations of nutrients and deliver consumers a better nutritional bargain per calorie consumed."

The nutritional decline findings alone give reason to eat organic fruits and vegetables and eat more of them. In fact, for nearly all nutrients, organic fruits and vegetables remain our most nutrient-dense foods. When asked the best way for people to buy high quality fruits and vegetables, Davis said, "If the evidence holds up, the only sure remedy available will be going back to older, lower yielding varieties. A few specialty farmers are doing this already, for reasons of flavor, color

and novelty, for example "heirloom" varieties. One thing that might help, when selecting vegetables and fruits at the store, choose the smallest specimens, because they may have smaller dilution effects. I do this, when the pricing is per pound. Wine makers say that the smallest grapes make the best wines."

For a family eating fruits and vegetables, how much more do they need to eat to fulfill USDA nutrition needs?

"The median declines we found from data published in 1950 to 1999 ranged from 6% to 38%, with an average around 15%. So 15% more vegetables and fruits would theoretically make up the difference, with very little increase in calories. But to reach 5 to 9 servings per day, most Americans would need to make much larger increases," Davis said.

This information makes the updated food pyramid not so much current as reflective of the need for an increase in fruits and vegetables in order to get the same nutritional benefits. Davis was asked his views concerning the USDA food pyramid.

"It's good in many ways. I question the idea, however, that grains, even whole grains, are the best foundation for everyone." Davis said. "Another big problem, but not with the pyramid itself, is that Americans on average don't even come close to the recommendations to limit added sugars, added fats and oils, and white flour and white rice."

"Which brings up another point," Davis emphasized. "For those who are concerned about nutrient losses in foods, and Americans should be concerned, the biggest problem and the most room for improvement is not with our current food crops. It is with what we do to with the major portion of them, calorie-wise after harvest. An amazing two-thirds (2/3) of American calories, on average come from depleted, man-made sources such as purified sugars, added fats and oils, white flour, white rice, and distilled liquor," Davis said. "All of these items have suffered much deeper and broader nutrient losses than the nutrient declines we and others report in vegetables and fruits."

"The remedy is available now to everyone, with no change in agricultural methods: Eat more whole foods, with the nutrients they had when they grew, and much less of these badly depleted, non-whole foods that never existed in nature. This is a very old message that most Americans don't readily welcome or don't think is important."

Davis was asked how he would reorganize the current system of corporate farming to make it nutritionally better for consumers. Davis was clear, "I think the way for this to happen is for aware consumers to be willing to pay more for foods that are grown in ways that they prefer. These preferences can involve higher levels of nutrients and phytochemicals where they can be documented. Fruits and vegetables

with more flavor and greater maturity, especially fruits. Fruits and vegetables from local sources grown using lower levels of pesticides and herbicides."

That conclusion certainly jives with the Organic Authority's fruit and vegetable of choice, as always and in one word, organic.

<http://www.organicauthority.com/organic-food/organic-food-articles/declining-nutritional-value-of-produce-due-to-high-yield-selective-seed-breeding.html>