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01/19/2006

Model of Digestive System Helps Put the 'Function' into Functional Foods

COLUMBUS, Ohio -- An Ohio State University study examining how the body's cells absorb certain nutrients could have global implications in reducing the incidence of blindness.

"The presence of a nutrient or bioactive compound in a food does not necessarily mean that it will be efficiently absorbed and delivered to target tissues," said Mark Failla, chair of the Department of Human Nutrition in Ohio State's College of Human Ecology and scientist with the Ohio Agricultural Research and Development Center. The extent of a nutrient's absorption into the body from foods can vary from less than 1 percent to 100 percent, Failla said.

The more a compound is absorbed, the more effective it is. But absorption efficiency can vary for a number of reasons, including the chemical structure of the compound, the variety of the plant source of the food, the style of food processing and preparation, other components of the meal, and physiological factors, Failla said.

"In reality, we don't eat chemicals, we eat foods, and we eat meals," Failla said. "So it is essential to study the absorption and metabolism of nutrients and bioactive components in the context of actual foods and meals if we're going to develop optimal functional foods."

Failla and a colleague at the University of Wisconsin are studying ways to test the absorption and metabolism of beta-carotene, a precursor of vitamin A, from different varieties of corn and sweet potatoes. "Ideally, you would want to conduct these tests on humans," Failla said. "But that's extremely expensive and labor-intensive."

Instead, the scientists are comparing results from two different systems -- a laboratory model and an animal model. The project is funded by a \$200,000 grant from the international research organization HarvestPlus which receives the majority of its funds from the World Bank and the Gates Foundation.

The work focuses on what happens to nutrients and other compounds from foods during their transit through the digestive tract, into intestinal cells, and, finally, into blood. In Ohio, Failla and his team simulate the biochemical reactions that occur in the stomach and small intestine and expose human intestinal cells grown in his lab to digested foods. His results are being compared with those of Sherry Tanumihardjo, associate professor in the Department of Nutrition Science and the University of Wisconsin-Madison. Tanumihardjo is conducting similar studies examining beta carotene absorption from the test varieties of corn and sweet potato and its conversion to vitamin A in Mongolian gerbils. If results using the laboratory and animal models closely match, it will pave the way for scientists to use Failla's faster, more economical model to screen nutrient bioavailability from various foods and meals prepared in culturally traditional ways.

The study focuses on corn and sweet potatoes because they are staples in developing countries in South America and sub-Saharan Africa. The goal is to identify varieties of plants that can best reduce vitamin A deficiency, a problem that causes more than 500,000 children to go blind each year and is a leading cause of child mortality. The long-term goal of these and other collaborating researchers is to identify crop varieties with highly bioavailable nutrients such as provitamin A, iron, zinc and protein, for genetic crossing with currently used varieties of high-yielding crops that are not nutritionally dense. The aim is to produce

new hybrids that would significantly curtail deaths and disease caused by malnutrition in the developing world.

"It is estimated that the human diet contains as many as 20,000 compounds," Failla said. "Fifty or 60 of these are classified as essential, whereas many others possess anti-inflammatory, anti-microbial and anti-carcinogenic properties. The question is, how can we possibly test the bioavailability of all these compounds from a wide variety of food sources?" The hypothesis is that the system Failla is testing will streamline the research process and allow efficient testing of multiple nutrients and bioactive compounds from a wide array of foods. However, he doesn't envision this process eliminating the need for all animal or human testing.

"Assume there are 25 different varieties of tomato with varying levels of different types of lycopene," a nutrient that has been linked to possibly reducing the incidence of prostate cancer. "Imagine that instead of testing all of those tomatoes in human subjects to see which has the highest extent of lycopene absorption, we could use the model system to categorize the varieties into high-, moderate- or low-lycopene availability. This would provide investigators with direction for testing a limited set of varieties with the most desirable characteristics in appropriate animal models and then in humans."

The support from HarvestPlus is expected to provide the results to assess the validity of the laboratory approach within two years.

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