Nutrient-Rich Dairy May Find New Role in Functional Foods

■ **Contributed by** *Bill Haines*

Dairy products are nutrient-dense foods that are important to good health, according to 2005 federal dietary guidelines, which call upon Americans to consume at least three servings of low-fat or fat-free milk or milk products a day. But new research suggests that, in some cases, being a cornerstone of the American diet is potentially just a starting point for dairy.

Researchers are probing possible synergies between dairy and probiotics, which are living microorganisms, that, when consumed in sufficient amounts, provide health benefits beyond basic nutrition. Other scientists are examining how to add vitamins to natural cheese for the health and nutrition of kids and adults. Still other researchers are looking at nutrient-rich milk as a delivery system for dietary supplements that people often consume in pill form, such as glucosamine and chondroitin.

Strengthening Probiotics

Probiotics, which most consumers associate with yogurt, have been shown to play beneficial roles in gut health, including reducing the duration or severity of a variety of diarrheal diseases and helping to protect against infectious diseases, by decreasing Helicobacter pylori infections. Additional possible health benefits attributed to probiotics include a decrease in colon cancer risk, enhancement of the immune system, reduction in symptoms of inflammatory disorders such as inflammatory bowel diseases, alleviation of some symptoms of irritable bowel syndrome, and prevention of allergic symptoms.

Genetic research at the Southeast Dairy Foods Research Center at North Carolina State University in Raleigh centers on enhancing the survival and activity of probiotics in dairy foods, which are considered to be excellent vehicles for probiotics. Genomic analysis of probiotics, specifically Lactobacillus acidophilus and Lactobacillus gasseri, is helping to identify how probiotic cultures colonize, interact and function with human tissues to elicit benefits.

Furthermore, these studies are investigating whether these key mechanisms, between probiotic cultures and human health, are positively affected by dairy foods or components. Due to the long history of probiotic lactic acid bacteria in dairy foods and fermented milks, the dairy environment may promote probiotic survival and activity.

■ **Genomics suggests that the dairy environment may promote probiotic survival and activity.**

Todd Klaenhammer, professor of food science, microbiology and genetics, and his group at the Southeast Dairy Foods Research Center have recently published the complete genomic sequence of L. acidophilus. Using that information, the research team successfully directed gene knockouts into specific locations of the L. acidophilus genome to disrupt a number of surface-associated proteins, resulting in alterations in cell shape or loss of their ability to attach to intestinal epithelial cells. The researchers' genomic analysis also identified a metabolic pathway in L. acidophilus that is responsible for utilization of fructooligosaccharide (FOS), a prebiotic often added to yogurt and fermented dairy beverages.

Klaenhammer and other scientists discovered that turning on a group of genes inside L. acidophilus allows it to transport and internalize FOS. Once inside the bacterium, FOS is digested by cutting the individual fructose molecules off the end of the long oligosaccharide chain. These molecules are then metabolized to provide energy to the organism.

This research explains the connection between prebiotics, such as FOS, and the increase of certain types of probiotic organisms in the gastrointestinal (GI) tract, says Klaenhammer. Because L. acidophilus uniquely transports and internalizes FOS before utilizing, other competing bacteria cannot metabolize FOS, or its component sugars, possibly giving the probiotic bacteria an advantage for survival and retention in the intestine. Klaenhammer's research group is now studying other genes believed to be important to surviving gastric passage, attaching to the intestinal mucosa and

Photo source: DSM Food Specialties

producing antimicrobial compounds that may promote the competitive ability of probiotic cultures.

Vitamin-Enriched Natural Cheese

Many cheeses contain a high concentration of essential nutrients, in particular high-quality protein, calcium and phosphorus.

Researcher Carl Brothersen, associate director of the Western Dairy Center at Utah State University in Logan, has developed a method to enhance this nutritional profile by adding vitamins. "We were looking for ways to increase the utilization of cheese and make it a more value-added product," says Brothersen.

Using a high-pressure injection technology, Brothersen injected liquid vitamin D, B_6 and folic acid into Cheddar and mozzarella cheese. "B_6 and folic acid are precursors in some of the metabolic pathways for flavor development. That is, the starter bacteria have mechanisms for converting them into cheese flavor compounds," explains Brothersen. "We wanted to see if addition of B_6 and folic acid to Cheddar cheese would change the flavor profile of the cheese, and change the growth patterns of the starter and non-starter bacteria. We chose vitamin D because of the aging population, osteoporosis and the role of vitamin D in calcium uptake."

Testing the vitamins after a 330-day aging period, Brothersen found they did not markedly affect the ripening process or flavor of the cheeses. Furthermore, the cheese microflora did not eliminate the vitamins. At the end of the 330-day period, the highest vitamin loss was the folic acid (40%) in mozzarella and the lowest loss was vitamin D (0%) in mozzarella. The taste panelists could not detect any difference in flavor between the vitamin-injected cheese and the non-injected controls.

The injection system may have the potential to work in any natural cheese, according to Brothersen. "Any vitamin can be injected into cheese as long as it will stay in an aqueous suspension or solution and is not too viscous," he says. "We are currently working on optimizing the high-pressure injection system" to determine if a consistent uniform distribution of the targeted level of vitamin can be obtained in the final product.

Brothersen is working with cheeses made by different procedures, such as milled curd, stirred curd and pasta filata cheeses, rather than a specific cheese type. Because the vitamins are injected directly into the natural cheeses, the vitamins would not affect whey handling and processing.

■ **Nutrient-rich dairy foods are ideal delivery systems for various "functional" ingredients.**

■ **Similar to how high-pressure injection technology can be used to flavor and color cheese, it can be used to inject cheese with vitamins.**

Novel Milk Supplements

Research at the University of Minnesota in Minneapolis/St. Paul is looking at the stability of specific dietary supplements when they are added to ultra-high-temperature (UHT) processed milk. This could ultimately lead to the development of single-serving fluid milk products that may provide health benefits for the aging population by using nutrient-rich dairy foods as a delivery vehicle for certain dietary supplements.

Ted Labuza, professor in the university's Department of Food Science and Nutrition, is investigating the stability and shelf life of the following supplements in fluid milk: Glucosamine, chondroitin sulfate, lactoferrin, soy isoflavones and creatine. Each supplement, often taken in pill form, is thought to offer health benefits. For example, both glucosamine and chondroitin sulfate are believed to aid in the promotion and maintenance of cartilage. Lactoferrin may help improve gut immune resistance to pathogens. Soy isoflavones are believed to provide benefits in menopause, heart disease, osteoporosis and colon cancer. Creatine is thought to improve muscle mass.

Each of these supplements was introduced into specially prepared 4-ounce (100 ml) servings of milk that were then subjected to high heat. "We are looking at the stability of these nutraceuticals during heat processing and then in three different venues: A refrigerated product with good stability of the dietary supplement, but short shelf life, an extended-shelf-life product at refrigerated temperatures and a room-temperature-stable product," says Labuza.

The project is currently in the last three months of storage stability research. To date, Labuza has found that stable chuggable milk-based beverages can be made with all of the evaluated nutraceuticals by pasteurization, UHT or a combination of membrane sterilization and aseptic filling. At room temperature, long-storage stability is possible for soy isoflavones, chondroitin and lactoferrin products. Glucosamine is reasonably stable at 4°C storage, but demonstrates 20% loss after two months. The results for creatine are not yet available. Labuza anticipates that a manufacturer interested in this technology would be likely to conduct sensory work.

For more information on these ongoing research efforts supported by America's dairy farmers, contact the Dairy Management Inc.™ (DMI) Dairy Technical Support Hotline at 800/248-8829. DMI offers a comprehensive technical support system with six dairy research centers, two application labs and more than 100 experts in research, applications, technology, nutrition and marketing. ■

Bill Haines is v.p. Product Innovation, Dairy Management Inc.™

For reprints of this article, contact Jill DeVries at 248/244-1726 or devriesj@bnpmedia.com.