

Promoting Satiety

By Marie Spano, MS, RD, CSCS, Contributing Editor

Satiety is the newest strategy for formulating weight-control products. Satiety involves both the psychological and physiological feeling of fullness—a feeling that may be key to managing weight. When dieters cut their caloric intake, hunger pangs can sabotage their weight-loss efforts. “Helping dieters achieve or enhance the feeling of fullness will support their willpower to cut unhealthy snacking between meals,” notes Ram Chaudhari, Ph.D., FACN, CNS, senior executive vice president and chief scientific officer, Fortitech, Schenectady, NY. Therefore, functional ingredients that boost satiety play a vital role in weight management.

Psychological satiety is the desire to eat regardless of hunger and is associated with the sight and smell of food, enhanced portion size, variety, eating with company, social events, and time of day (*Physiology & Behavior*, 2009; 97(1):44-51). Physiological satiety is achieved by a full stomach and intestine, both of which trigger the release of the hormones cholecystokinin (CCK), glucagon-like peptide-1 (GLP-1) and peptide YY (PYY)—all of which are involved in a feedback loop letting our brain know the stomach is satisfied (*Nutrition, Metabolism and Cardiovascular Diseases*, 2008;18(2):158-168).

Functional ingredients are primarily aimed at enhancing physiological satiety and may include a wide variety of fibers, protein and combination ingredients engineered to alter our hormonal response to food, thereby boosting satiety and potentially enhancing weight loss over time.

Fullness with fiber

Fiber plays an important role in weight management, yet the average American’s fiber intake is far below the Dietary Guidelines for Americans recommendation of 14 grams per every 1,000 calories consumed. “A large body of research has examined fiber and satiety and found, in addition to slowed gastric emptying, fibers may also affect satiety hormones produced in the body,” notes Jocelyn Mathern, MS, RD, technical health specialist, Frutarom USA, North Bergen, NJ. “Several types of fiber have satiety-enhancing properties, including galactomannan, glucomannan, inulin/oligofructose and resistant starch. Water is also a key factor in building satiation, particularly when it is incorporated into the food’s matrix. Fiber brings a lot of water into a formulation because of its water-binding properties.”

Galactomannan is a soluble fiber that may enhance satiety by forming a viscous gel in the stomach, which slows gastric emptying (the rate of food leaving the stomach), thereby enhancing fullness. In a clinical trial using Frutarom’s galactomannan fiber, an 8-gram dose significantly increased mean ratings of satiety and fullness, and reduced ratings of hunger and prospective food consumption in comparison to 0 or 4 grams of galactomannan fiber. However, no significant differences were noted between groups in total energy intake throughout the day (*Phytotherapy Research*, 2009; 23(11):1,543-1,548).

Galactomannan does not alter the shelf stability of products and is best suited to foods or powdered beverages. It cannot be formulated into RTD beverages. The greatest challenge with using fiber for satiety is that large amounts need to be consumed and in larger doses; galactomannan, like other types of fiber, can decrease the palatability of a product. The amount of galactomannan that can be added depends

upon the actual food or beverage. The presence of gums, stabilizers, whole grains and other ingredients all impact how much galactomannan should be added. In general, beverages will become too thick, and food products may develop a less desirable texture when too much is added.

Glucomannan is a soluble fiber derived from the root of the konjac plant. In a double-blind, placebo-controlled 16-week trial comparing consumption of a mixed-fiber supplement (3 grams *Plantago ovata* husk and 1 gram glucomannan) taken two or three times daily to placebo, both doses of the fiber supplement significantly increased post-meal satiety. And, the two groups consuming the fiber supplements tended to lose more weight than the control group, although the between-group differences were not significant (*British Journal of Nutrition*, 2008; 99(6):1,380-1,387).

Glucomannan gum is commonly used as a gelling agent, thickener, film former, emulsifier, stabilizer and soluble-fiber source. It is used in baked goods, beverages, breads, batters, condiments, dairy products, salad dressings, soups, gravies, snack foods and other products. Glucomannan powder helps thicken products and is used in sauces and baked products.

Inulin and oligofructose are naturally found in a wide variety of fruits and vegetables across the world. Oligofructose is a shorter subgroup of inulin. Both are soluble prebiotic fibers that promote the growth of probiotic (good) bacteria in our colon, yet they are not digested in the upper gastrointestinal tract (*Journal of Nutrition*, 1999:1,402S-1,406S). Inulin and oligofructose also increase the absorption of calcium and enhance calcium deposition into bone tissue (*British Journal of Nutrition*, 2007; 97(2):365-372).

In animal studies, inulin boosts satiety by modulating gastrointestinal peptides (*British Journal of Nutrition*, 2004; 92(3):521-526). "The current body of data on inulin and satiety is somewhat limited," notes Scott Turowski, technical sales manager, Sensus America, Inc., Lawrenceville, NJ. "However, Sensus the company launched a large-scale, clinical study to further investigate the topic. "The results of this study are expected to be available at the end of the year and will hopefully open the door to satiety-related claims on products containing chicory root fiber," he said. Chicory root is the primary ingredient source of inulin for the food industry.

Rodent studies show that oligofructose promotes weight loss in a similar manner as inulin—through satiety hormone secretion (*American Journal of Clinical Nutrition*, 2009; 89(6):1,751-1,759). However, very few human studies have examined oligofructose and satiety. A pilot study in 10 men and women found 8 grams of oligofructose consumed twice per day compared to placebo (dextrin maltose) reduced hunger and prospective food consumption after dinner (*European Journal of Clinical Nutrition*, 2006:60:567-572). In a randomized, double blind, placebo-controlled trial, 48 overweight and obese adults received either 21 grams oligofructose per day or a placebo (maltodextrin) for 12 weeks. Oligofructose suppressed the "hunger" hormone ghrelin and enhanced PYY, a gut hormone peptide that is released in response to a meal and regulates food intake. The oligofructose group self-reported a significant reduction in calorie intake during the intervention, though total weight loss was not significant.

Commercial-grade inulin does not alter the flavor of food yet improves the mouthfeel, stability and overall acceptability of low-fat items. Oligofructose has a sweet flavor that improves the flavor and sweetness profile of low-calorie foods and texture of low-fat foods (*Journal of Nutrition*, 1999:1,402S-1,406S).

Protein and amino acids

“A number of studies published over the past 10 years indicate that proteins are the most satiating of the calorie-containing nutrients (carbohydrates, fats, proteins),” says Mitch Kanter, executive director, Egg Nutrition Center, Park Ridge, IL.

Whey consumption increases the release of both CCK and GLP-1, and whey may be more satiating than some other types of protein. Collectively, two separate studies showed that ad libitum food intake was significantly reduced when subjects were given a liquid supplement containing 48 grams of whey compared to 48 grams of casein 90 minutes prior to a meal. The 48-gram dose of whey resulted in significant increases in CCK and GLP-1 (*British Journal of Nutrition*, 2003; 89:239-248). Another study in 25 healthy adults found that a breakfast custard containing 10% of energy from whey, in comparison to 10% from soy or casein, decreased hunger to a greater extent 180 minutes post consumption (*Physiology & Behavior*, 2009; 96(4-5):675-682).

Whey is often used in food and beverage applications, including bars, smoothies, dry mixes, sauces, dips and baked goods.

According to Kanter: “Recent studies with eggs have tended to corroborate the satiety-inducing benefits associated with protein. For example, in a study of overweight and obese women who consumed either an egg breakfast or an equal-calorie bagel-based breakfast, the women who consumed eggs reported greater satiety throughout the morning, and they consumed fewer calories at the lunch meal than the women who consumed the bagel breakfast. And this is not an isolated finding. A recently published study found that eating eggs for breakfast as a part of a weight-reduction diet allowed subjects to lose more weight than when they consumed a higher-carbohydrate breakfast over a two-month period.”

Currently undergoing clinical trial testing for efficacy, a whey-derived milk mineral complex from Glanbia Nutritionals, Inc., Monroe, WI, may improve overall body composition through body-fat loss and maintenance of lean body mass. It is currently available only in Europe and Asia, and can be formulated into ready-to-mix beverages, confectionery items, bars, and dairy and sports nutrition products.

Helpful extracts

An extract made from *Caralluma fimbriata* (an edible cactus commonly used as a vegetable in several regions of India), manufactured by Gencor Pacific, Anaheim, CA, was put to the test in a placebo-controlled randomized trial in 50 overweight men and women. The subjects received either 1 gram of the extract daily or a placebo for 60 days and were given general instructions on physical activity and diet. Both waist circumference and hunger levels declined significantly in the *Caralluma* group compared to control. The experimental group also showed a decrease in body weight, hip circumference, body fat and energy intake in comparison to the control group, though the differences were not significant (*Appetite*, 2007; 48(3):338-44). According to a Gencor report submitted to the FDA, *Caralluma fimbriata* contains pregnane glycosides that might block the activity of citrate lyase and malonyl coenzyme A, thereby blocking the formation of fat by the body. The company also believes compounds in the extract affect the appetite control mechanism of the brain. The ingredient is heat- and pH-stable, and has been incorporated into beverages, smoothies, meal replacements, capsules, tablets, chocolate and baked goods.

A potato extract from Kemin Industries, Inc., Des Moines, IA, is standardized to contain 5% proteinase inhibitor II (PI2), a protein naturally found in white potatoes. Research conducted by the company indicates that PI2 enhances CCK release and reduces post-prandial blood glucose (*JANA*, 2003; 6(1):29-38). The extract can be used in a variety of food applications and is currently being formulated into yogurts, bars and chocolates. Kemin Industries recommends 15 mg PI2 formulated into products.

Useful fats

Novel fats and fat emulsions can enhance physiological satiety while providing the mouthfeel that consumers crave.

Studies of an emulsion of palm oil in oat oil from DSM Nutritional Products, Inc., Ames, IA, show that 2, 4, 5 and 6 grams of the emulsion formulated into 200 grams of yogurt will significantly increase satiety and decrease food intake 36 hours post-consumption (*European Journal of Clinical Nutrition*, 2002; 56(4):368-377; *Physiology & Behavior* 2008; 95(1-2):114-117; *International Journal of Obesity* 2001; 25(10):1,487-1,496). The ingredient is best suited to dairy products.

Korean pine nut oil, rich in pinolenic acid, is a promising satiety ingredient that works by modulating CCK secretion. An in vitro study examining Korean pine nut free fatty acids vs. several other dietary fatty acids as controls found that the pine nut oil produced the most-pronounced effect on CCK (*Lipids in Health and Disease*, 2008:7-10).

In a randomized, crossover, placebo-controlled study in overweight post-menopausal women, 3 grams per day of a Korean pine nut oil from Lipid Nutrition, Channahon, IL, resulted in significant increases in CCK over a 4-hour period and decreased appetite as measured by visual analogue scales in comparison to 3 grams of olive oil placebo (*Lipids in Health and Disease*, 2008:1-10). The oil form of the ingredient has been used in beverages, supplements, chocolates and bars, while the powder form can be used in these applications, as well as in shakes, dairy products and baked goods.

A diglyceride-rich oil from Kao Health and Nutrition, Decatur, IL, may suppress the accumulation of body fat in comparison to typical triglyceride-rich oils. Several studies collectively indicate the oil may help prevent the accumulation of body fat associated with a high-fat meal, augment weight and fat loss as part of a reduced calorie diet, decrease abdominal fat, and lower serum triglycerides (*Journal of Nutrition*, 2000; 130(4):792-797; *Journal of the American College of Nutrition*, 2000; 19(6):789-796). The oil can be substituted for regular oil in salad dressings, and for sautéing, cooking, frying and baking.

Other ingredients

A range of other ingredients, including herbs, nuts and select components of fruits have shown promise in the area of satiety.

Herbs. The herbs yerba maté, guarana and damiana are popular in non-Western cultures for their potential to enhance weight loss. However, only one clinical trial has examined the effect a combination of the herbs (YGD) has on satiety. In the study, three capsules of YGD (one capsule contained 112 mg yerba maté, 95 mg guarana and 36 mg damiana extract) taken before each meal delayed gastric emptying and enhanced weight loss over a 45-day period in overweight adults (*Journal of Human Nutrition and Dietetics*, 2001; 14(3):243-50).

Frutatrom, North Bergen, NJ, has GRAS self-determination for its yerba maté; guarana and damiana are listed as food additives by the FDA.

Nuts. Nuts are rich in several nutrients, minimally impact blood sugar, contain heart-healthy monounsaturated fat and may enhance satiety. Epidemiological studies show an inverse relationship between nut consumption and BMI, and intervention trials found less than predicted weight gain when nuts were included in the diet. Scientists believe that nuts satiate the appetite and somehow offset the energy consumed either through increased energy expenditure and/or inefficient use of calories (*Asia Pacific Journal of Clinical Nutrition*, 2008; 17(Suppl 1):337-339).

Hydroxycitrate (HCA). This component of the fruit of the *Garcinia cambogia* tree plays a role in carbohydrate and fat metabolism. Studies in mice show that HCA suppresses food intake, but the two human studies using HCA are equivocal (*Physiology & Behavior*, 2000; 71(1-2):87-94; *International Journal of Obesity Related Metabolic Disorders*, 2002; 26(6):870-872).

Satiety is a rapidly evolving science, but could yield real results. “Functional-food products specifically designed for weight loss and long-term weight management that include satiety-inducing ingredients can play an important part in facilitating the fight against obesity,” notes Chaudhari. These products should be portion-controlled and have appealing flavor and mouthfeel so consumers will consume them on a regular basis, he says.

In addition, food and beverage manufacturers may want to consider fortification and enrichment of weight-management products because, as indicated by Chaudhari, “a reduction in caloric intake is not accompanied by a parallel reduction in micronutrient needs. Therefore, it is important for anyone that is trying to lose weight to eat a more nutrient-rich diet to protect their nutritional status and their health.”

Marie Spano, MS, RD, CSCS, is a nutrition communications expert whose work has appeared in popular press magazines, e-zines and nutrition-industry trade publications. She has been an expert guest on NBC, ABC and CBS affiliates on the East Coast. For more information, visit www.mariespano.com.