Fiber Files

By Cindy Hazen, Contributing Editor

Fiber is one nutrient everyone agrees is important in a healthy diet. But, “Hard as it may be for you to believe, most people don't sort their breakfast cereal numerically by fiber content,” as Leonard says to Sheldon on the TV show "The Big Bang Theory."

Most of us don’t do the math to be sure we’re consuming sufficient fiber each day. The average American intake is 15 grams per day. Dietary Guidelines for Americans 2010 considers 25 grams per day adequate for women. Men should consume at least 38 grams per day. Even when consuming a diet rich in naturally occurring fiber, it’s easy to fall short of the recommended daily allowance. Here’s where the food industry can help.

Adding more fibers

According to current regulations, a food item can carry the claim of “more or added fiber” when it contains at least 2.5 grams of fiber more than the reference. A “good source of fiber” claim can be made when the food item contains 2.5 to 4.9 grams of fiber; and a “high fiber” claim can be made when a food item contains 5 grams or more fiber per serving.

The nutritional panel discloses dietary fiber. This may be insoluble, meaning it is non-digestible and will pass through the digestive tract without contributing any calories. “Soluble fiber, on the other hand, can be used by bacteria in the colon to produce fatty acids, which can be used by the human body,” says Ramakanth Jonnala, Ph.D., project leader cereal science, International Fiber Corporation (IFC), North Tonawanda, NY. Soluble fibers contribute calories. An additional declaration for soluble fiber may be listed on the nutritional panel.

Different types of insoluble and/or soluble fibers can be added to food formulas, but selecting the right type of fiber is critical. Some commonly used fiber ingredients include powdered cellulose, white wheat fiber, bamboo fiber, sugar cane fiber, pea fiber, cottonseed fiber, oat fiber, sugar beet fiber and potato fiber. And there is significant fiber in other products, everything from whole grains to certain vegetables.

“Every formulator has his or her own specific criteria for a fiber ingredient, so depending on the product and the consumer it targets, oat fiber, soy fiber, pea fiber or cellulose fiber may be appropriate,” says Rajen Mehta, Ph.D., director, fiber applications, SunOpta Ingredients, Chelmsford, MA. Oat fiber, for example, can be used to meet a variety of textural targets, from crunchy to chewy to soft.

Fibers provide functionality and fortification to food products. Jonnala points out fibers can be used to maintain volume and dimensional stability while increasing the shelf life of baked products.

Rice fiber is a gluten-free ingredient that delivers a highly concentrated source of insoluble fiber (more than 90% total dietary fiber, or TDF). “It has a very bland flavor and silky smooth texture,” says Mehta. Rice fiber can be used to enrich or fortify a variety of products. It can also be used to enhance texture, control moisture or reduce calories.

Mehta recommends using rice fiber in baked goods, cereals, snacks, nutrition bars, baking mixes, nutraceutical products and, especially, gluten-free products.

Formulating with fiber

Product designers need to be aware of how added fibers can change the formulation parameters, especially the amount of water added to bakery products. Finding the ideal percentage of water to be added to a fiber-rich formula may require some trial and error, depending on the fiber, the application, presence of other ingredients and processing parameters.

“Typically, for bakery products, about 1.5 lbs. of additional water needs to be used per lb. of rice fiber when the fiber is added on flour-weight basis. For many products, such as snacks and cereals, the water addition rate is considerably lower. This water addition rate is similar to other insoluble fibers.”

Water-binding capacity of insoluble fibers varies with the type of fiber and the particle size. Longer length fibers absorb more water. White wheat fiber, for example, can range from 3.8 grams water per gram of 22 micron fiber to 10.0 grams water per gram of 400 micron fiber.

“Although there are no regulatory limits on the levels of fibers that can be added to bakery products, usage levels are normally self-limiting,” says Jonnala. Breads can incorporate up to 9% fiber. Cookies and biscuits can practically use 5% to 6% fiber. Muffins, pound cakes, pasta, wheat-flour tortillas and pizza crust can be formulated with 4% to 5% fiber. Layer cakes should not exceed a 3% fiber addition.

In high-fiber, whole-grain breads, “addition of fibers needs several processing adjustments, including increased water absorption and longer mixing and fermentation times,” Jonnala cautions “Also, optimization of the amounts of wheat gluten and emulsifiers added would help to improve the dough strength and gluten network. Incorporation of honey into this formulation can mask the bitter taste of the finished product normally associated with the use of bran. If the ‘sponge and dough’ method is used, all fibers in the formulation should be added in the dough for best results. Addition of fibers in the sponge would interfere with yeast activity and may collapse the bread while proofing and/or baking.”

In batter-based products, such as whole-wheat muffins and layer cakes, where the product symmetry and volume are of importance, optimizing the batter viscosity with water adjustments may be crucial. “Using higher levels of emulsifiers to improve the batter aeration capacity will also result in better mouthfeel and texture in the finished product,” Jonnala says.

Unlike baked goods, fiber added to meat products cannot be used for fiber claims. “However, it can still play a fortifying role when one looks at the finished food product as a whole,” says Vareemon

Tuntavanich, Ph.D., project leader, meat science, IFC. “For example, pizza and lasagna with fiber-added sausages can be considered to be high-fiber foods, but not the sausage by itself. The level of fiber usage typically depends on the product type and desired outcome. In general, meat products can contain fibers for improved functionality in the range of 0.5% to 3.0%.” Some of the functionality benefits include: enhanced cooked yield, decreased moisture loss, enhanced dimensional stability (e.g., reduced shrinkage), improved texture, increased juiciness and tenderness, increased overall product acceptability, and enhanced freeze/thaw stability.

Formulators should first understand the physical and chemical properties of their product in order to select the best fiber for their application. “For example, in an emulsified meat product, such as hot dogs, a short fiber can be used to mimic an emulsifying agent,” Tuntavanich says. “The fiber will have to react to both water and oil phases, while providing a texture similar to the finished product. How and when the fiber is added to the product can also be important. In most meat applications, fibers can be preblended with spices and other dry ingredients and be used as a dry mix. However, there may be other applications where the fiber may function better if it is hydrated before use. Prehydration of fibers can maximize fat reduction (e.g., during frying), which in turn will maximize caloric reduction. Since fibers tend to absorb large amounts of water, product developers will have to be concerned not only about the type and level of fiber usage, but the bigger picture of how this will affect the entire formulation, and potential impacts on other ingredients should also be considered.”

Way of least resistance

Look to resistant starch as another ingredient to boost insoluble fiber content. Resistant starch is a dietary fiber that is not digested in the small intestine. It reaches the large intestine (colon) where it is fermented and acts as a colonic nutrient. “Resistant starch is more easily fermented than other dietary fibers and stimulates the growth of the beneficial acidogenic bacteria, which is apparent from the high levels of butyric acid produced,” explains Wendy Erickson, technical service manager, texturizing solutions, Cargill, Minneapolis.

There are four classes of resistant starch: RS1 is derived from whole grains; RS2 is a granular, ungelatinized starch found in potatoes or high-amylose starch; RS3 is formed after gelatinization; and RS4 is a chemically modified starch.

Cargill offers an RS3 starch. Erickson says it has more than 80% total dietary fiber, “therefore contributing substantially to TDF daily targets and opening the door to dietary fiber claims,” she says. This resistant starch is suitable for the formulation of healthy bakery products “not only for its fiber content, but also for the production of lower-calorie foods because of its caloric value of 1.9 kcal per gram. Nutritional benefits might include fiber claims (good or excellent), caloric reduction, prebiotic and glycemic-index control.”

Because of its fine granulometry, the neutral taste and smooth mouthfeel of these tapioca-based starches “avoid the unpleasant sandiness often experienced with high amylose corn-based resistant starch. The low water-binding capacity and the low viscosity permit high inclusion levels while avoiding significant formulation changes,” Erickson says.

Resistant starch can provide health benefits, too, by lowering the glycemic impact of a food. Literature from Ingredion, Westchester, IL, cites more than 20 human clinical trials that examine the glycemic and short-term insulin response to foods containing the company's RS2 resistant starch or resistant starch from high amylose corn. Not only does the ingredient itself halve this effect, its substitution of more glycemic carbohydrates will lower the glycemic response even further, the company notes.

A digestion-resistant maltodextrin from ADM/Matsutani LLC, Itasca, IL, is a soluble corn fiber containing 90% concentrated soluble dietary fiber. It is used in a variety of applications, including bars, baked goods, cereals, dairy products, cereals and frozen foods. There is also an agglomerated form that is ideal for instant drink mixes and applications where quick dispersion and dissolution are key to final product success.

"Digestion-resistant maltodextrin is highly soluble in aqueous solution and is extremely stable, maintaining fiber content during high-heat processing and in low-pH conditions," says Kati Ledbetter, product development scientist, ADM, Decatur, IL. "Additionally, it adds no inherent flavor or taste. Digestion-resistant maltodextrin forms a clear solution and can be added to any formulation with minimal adjustment."

It is water soluble up to 70% (w/w) at 20°C. "In many cases, digestion-resistant maltodextrin can be added right into the formulation with very minimal changes or water adjustments," Ledbetter says.

When all claim requirements are met, "2.8 grams of digestion-resistant maltodextrin will deliver 2.5 grams of fiber per serving to give a 'good source of fiber,'" says Ledbetter. "In addition, 5.6 grams of digestion-resistant maltodextrin will deliver 5.0 grams of fiber per serving to give a 'excellent source of fiber.'"

ADM/Matsutani also offers a liquid form of soluble corn fiber that has the functionality of a corn syrup, and can be labeled as a corn syrup or soluble corn fiber. It contains 75% soluble dietary fiber on a dry basis. Ledbetter says this has the ease-of-handling benefits of a liquid product, as well as added sweetness from the dextrose in the syrup. "This product is ideal for bakery, bar and beverage applications," she says. "A great example is using the liquid form of soluble corn fiber as part of the binding system of particulate-type bars to increase the overall fiber content of the finished product." Within the soluble dietary fiber line, ADM offers a product that contains digestion-resistant maltodextrin combined with the sweetness of natural honey and purified steviol glycosides. Ledbetter recommends using this product to replace liquid honey or sugar to reduce calories and add fiber.

These soluble-fiber ingredients "can be used to enhance the fiber content of applications, as well achieve a sugar and calorie reduction when used to replace sugars and higher caloric ingredients," Ledbetter says. "For example, digestion-resistant maltodextrin contains 1.6 kcal per gram, and has a typical value of 0.2 gram of sugars per 10 grams of ingredient, so when used to replace 4 kcal per gram carbohydrates, it can be used to achieve a total calorie reduction."

Gums add fiber

Hydrocolloids are another source of soluble fiber. “They are typically between 70% to 90% soluble fiber; and the health benefits are widely studied,” says Karen Silagyi, food scientist, TIC Gums, Belcamp, MD. “Gums are primarily used for adding texture and stability; therefore, while selecting gums as a fiber source, these characteristics must be taken into account, as well.”

The road to a fiber claim can often merge insoluble and soluble fibers. “While insoluble fibers will not provide unwanted viscosity, they may add undesirable textures like particulates or roughness of mass, or visual defects such as settling,” Silagyi cautions. “On the other hand, soluble fibers dissolve or thicken water and must be carefully chosen for fiber fortification. In a product where low viscosity is desirable, such as a beverage, typically low-viscosity gums like gum acacia, inulin, low-viscosity guar, low-viscosity CMC (carboxymethylcellulose), or even some pectins are best. In soups, sauces and some dairy applications, where higher viscosity is desirable, developers may use higher-viscosity gums, like locust bean gum, xanthan or konjac, in order to take advantage of the texture and stability hydrocolloids provide in addition to the fiber benefits.”

When selecting hydrocolloids for fiber fortification, the same selection criteria that are used to select gums for texture or stability apply: product pH, desired viscosity, processing conditions and protein interactions.

“Additional water is not required for soups, sauces and beverages because the goal is to increase the concentration of fiber per serving,” Silagyi says. “However, for ease of processing, additional water may be used in baked goods like cookies, cakes or bread.”

With careful selection, hydrocolloids used for fiber fortification will also improve the texture or stability of a product. “For example, inulin is commonly used in ice cream at 0.5% to 1.0% to control ice-crystal growth and increase the consumers’ perception of creaminess,” Silagyi says. “Higher usage levels may qualify for a fiber claim, in addition to these product improvements. Often, multiple hydrocolloids are used together in formulating to optimize texture, stability and fiber content.”

Building a foundation

Starting with fiber-rich ingredients, such as legumes or whole grains, is a direct path to improving the nutritional panel. The USDA nutrient database attributes 8.7 grams of fiber to 100 grams of whole cooked black beans. Pearled barley, which is dehulled, has 3.8 grams of fiber per 100 grams. One hundred grams of oat flour has 6.5 grams of fiber.

Barley and oats contain beta-glucan, a soluble fiber associated with reduced risk of cardiovascular disease. FDA allows a heart-health claim for foods that contribute 3 grams or more per day of beta-glucan soluble fiber from either whole oats or barley, or a combination of whole oats and barley (Title 21 of the *Code of Federal Regulations*, Part 101, Section 81).

ConAgra Mills, Omaha, NE, offers barley flour with 30.6% fiber and 12.6% soluble fiber that can be used in breads, cereals, baked goods and bars.

Adding bran to a formula is a sure way to impact total dietary fiber. A new oat bran from Viterra, Kansas City, MO, for example, provides 20% soluble fiber. Grain Processing Corporation, Muscatine, IA, sells a corn bran with 80% minimum TDF.

“Wheat flour enables customers to include fiber on their nutritional panel,” says Dani Zinke, marketing associate, Horizon Milling, Minneapolis. “Using our whole-wheat flours, such as white spring whole-wheat flour can boost fiber levels, while maintaining baking performance and sensory profile. If bread is formulated with 100% whole-wheat flour, 3 grams fiber per serving can be achieved without adding additional fiber.”

Meeting the target TDF is important but not the endgame. “The ultimate goal is to have the least cost formulation while still meeting required fiber levels that consumers want while maintaining the ideal sensory profile,” says Zinke. Customers currently use many other forms of fiber to boost fiber levels in formulations for not only bakery products but many other categories.”

Mehta points out: “A product high in whole-grain content may not be necessarily high in fiber, depending on the source of the whole grain. More whole-grain products are being fortified with insoluble fibers. People are starting to realize that whole grain and fiber are not synonymous.”

Combing multiple sources of fiber is often the best option for high-level fortification. No matter the flag on the cereal box, the end goal has to be an appealing flavor and texture if Americans are going to boost their fiber intake.

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