Evidence-Based Approach to Fiber Supplements and Clinically Meaningful Health Benefits, Part 1

What to Look for and How to Recommend an Effective Fiber Therapy

Johnson W. McRorie, Jr, PhD, FACG, AGAF, FACN

Dietary fiber that is intrinsic and intact in fiber-rich foods (eg, fruits, vegetables, legumes, whole grains) is widely recognized to have beneficial effects on health when consumed at recommended levels (25 g/d for adult women, 38 g/d for adult men). Most (90%) of the US population does not consume this level of dietary fiber, averaging only 15 g/d. In an attempt to bridge this ''fiber gap,'' many consumers are turning to fiber supplements, which are typically isolated from a single source. Fiber supplements cannot be presumed to provide the health benefits that are associated with dietary fiber from whole foods. Of the fiber supplements on the market today, only a minority possess the physical characteristics that underlie the mechanisms driving clinically meaningful health benefits. The first part (current issue) of this 2-part series will focus on the 4 main characteristics of fiber supplements that drive clinical efficacy (solubility, degree/rate of fermentation, viscosity, and gel formation), the 4 clinically meaningful designations that identify which health benefits are associated with specific fibers, and the gel-dependent mechanisms in the small bowel that drive specific health benefits (eg, cholesterol lowering, improved glycemic control). The second part (next issue) of this 2-part series will focus on the effects of fiber supplements in the large bowel, including the 2 mechanisms by which fiber prevents/relieves constipation (insoluble mechanical irritant and soluble gel-dependent water-holding capacity), the gel-dependent mechanism for attenuating diarrhea and normalizing stool form in irritable bowel syndrome, and the combined large bowel/small bowel fiber effects for weight loss/maintenance. The second part will also discuss how processing for marketed products can attenuate efficacy, why fiber supplements can cause gastrointestinal symptoms, and how to avoid symptoms for better long-term compliance. Nutr Today. 2015;50(2):82–89

Johnson W. McRorie, Jr, PhD, FACG, AGAF, FACN, is a clinical scientist, Procter & Gamble, Mason, Ohio, where he has worked for 18 years. After serving in the US Army (509th Airborne, 221st Military Police), Dr McRorie completed an associate of arts degree in nursing and worked 14 years as an emergency department/intensive care unit RN at teaching hospitals that included Johns Hopkins Hospital in Baltimore and Children's Hospital National Medical Center in Washington, DC. He went on to complete a bachelor of science degree at the University of Maryland, followed by a dual PhD in neuroscience and physiology at Michigan State University, where he was also a physiology instructor for the medical school. Dr McRorie was previously the director of clinical affairs at Ethicon Endo-Surgery, a Johnson & Johnson company. His research interests include neurogastroenterology and motility, gastroesophageal reflux disease, and the physical effects of fiber supplements on metabolic syndrome, cholesterol lowering, improved glycemic control, constipation, diarrhea, and irritable bowel syndrome. He is a fellow of the American College of Gastroenterology, the American Gastroenterological Association and the American College of Nutrition, and a member of the American Diabetes Association.

The author is a full-time employee of the Procter & Gamble Company, which markets a fiber product.

Correspondence: Johnson W. McRorie, Jr, PhD, FACG, AGAF, FACN, Procter & Gamble, Mason Business Center, 8700 Mason-Montgomery Road, Mason, OH 45040 (mcrorie.jw@pg.com).

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There is general agreement with the statement that "fiber is good for you."[1–5] There is also general agreement that most people do not consume enough fiber in their diet and therefore would benefit from eating more fiber. Both statements are true when applied to fiber-rich whole foods (eg, fruits, vegetables, legumes, whole grains). The statements become less accurate, and less broadly applicable, when applied to fiber supplements. An important distinction is the difference between *replacement* and *supplement*. If patients are compliant with their clinician's advice to change their eating habits, and a substantial portion of a given diet is replaced by high-fiber foods, then both the total calories consumed and the glycemic index of the diet[6] should be significantly reduced. The resulting health benefits would support an association between consuming a wide variety of fiber types from whole food sources (eg, fruits, vegetables, legumes, whole grains) and observed improvements in health. This is in large part how epidemiologic studies show that a diet high in fiber consumption from whole foods is strongly associated with a reduced risk of heart attack, stroke, and cardiovascular disease.[7,8] It remains unclear, however, how much of the observed health benefit is actually attributable to the increase in dietary fiber, versus how much is attributable to a reduction in calories, elimination of less healthy dietary components, and an increased consumption of health-promoting constituents of the fruits, vegetables, and whole grains that are independent of the fiber component. Although it can still be argued that the optimal goal is to dramatically change the typical American diet to one that is replaced with high levels of fruits, vegetables, and whole grains, decades of experience show that only a minority of people consume the recommended levels of dietary fiber. The Institute of Medicine's Adequate Intake guideline recommends 14 g of dietary fiber per 1000 kcal consumed, which is about 25 g/d for women and 38 g/d for men.[9] In contrast to this recommendation, most (90%) of the US population does not consume enough dietary fiber. The average American consumes only 15 g of dietary fiber per day, and for those on a low-carbohydrate diet, total fiber intake may be less than 10 g/d.[10]

FIBER SUPPLEMENTS ARE AN ISOLATED FIBER SOURCE AND DO NOT PROVIDE MANY OF THE HEALTH BENEFITS ASSOCIATED WITH MEAL REPLACEMENT

In an attempt to overcome the gap between recommended levels of fiber consumption versus what is actually consumed in a typical American diet, fiber supplements have become a popular option as a convenient, concentrated source of fiber. Given that a fiber supplement is an isolated fiber source consumed in addition to an existing diet, and many of the additional benefits described above for meal replacement are not provided by adding an isolated fiber source, it becomes essential to have a more in-depth understanding of the unique physiochemical characteristics of each fiber supplement and how these characteristics are, or are not, associated with 1 or more clinically meaningful health benefits. The term *fiber supplement* implies that regular (daily) consumption will provide health benefits that may be missing from a low-fiber diet, but for most fiber supplements, this implication is not supported by clinical data. Health benefits derived from fiber supplements are primarily a function of the fiber's physical effects in the small bowel (eg, cholesterol lowering, improved glycemic control, satiety/weight loss) and large bowel (improved stool form and reduced symptoms in constipation, diarrhea, and irritable bowel syndrome [IBS]).

FIBER SUPPLEMENTS CAN BE DIVIDED INTO 4 CLINICALLY MEANINGFUL DESIGNATIONS

There are 4 main characteristics of fiber supplements that drive clinical efficacy: solubility, degree/rate of fermentation, viscosity, and gel formation. Solubility defines whether a fiber supplement will dissolve in water (soluble) or remain as discreet insoluble particles.[3,11] For soluble fibers, viscosity refers to the ability of some fibers to "thicken" when hydrated, in a concentration-dependent manner (Figure 1).[3,11–15] Gel formation refers to the ability of a subset of soluble viscous fibers to form cross-links, resulting in a viscoelastic gel when hydrated (Figure 2).[3,11–13]

FIGURE 1. Linear versus branched polymers. Drawings representing linear and branched polysaccharides. The volume "swept out" by a fully extended linear fiber is much greater than a fiber with an equal number of sugar units (same molecular weight) but with a "bush-like," highly branched configuration. Because the volume occupied by a polymer molecule is a function of the radius cubed, even small increases in effective hydrodynamic size can translate into a large increase in viscosity for linear fibers.

Fermentation refers to the rate and degree to which a dietary fiber, after resisting enzymatic digestion in the small bowel, can be degraded by gut bacteria, producing fermentation byproducts such as short chain fatty acids and gas.[3] Most fibers are not exclusively soluble or insoluble, so for the purposes of this review, the predominant characteristic will be discussed (eg, a fiber that is 70% soluble will be considered a soluble fiber). Using the 4 fiber characteristics described above, fiber supplements can be divided into 4 clinically meaningful categories:

1. **Insoluble, poorly fermented** (eg, wheat bran): when you think of "insoluble fiber," think of plastic (clinical studies described later actually used plastic particles to mimic effects of wheat bran): does not dissolve in water (no water-holding capacity); poorly fermented; can exert a laxative effect by mechanical irritation/stimulation of gut mucosa if particles are sufficiently large and coarse ("plastic effect"); small smooth particles (eg, wheat bran flour/bread) have no significant laxative effect; insoluble fiber does not gel or alter viscosity and thus does not provide other (gel-dependent) fiber health benefits.
2. **Soluble, nonviscous, readily fermented** (eg, inulin, wheat dextrin, oligosaccharides, resistant starches): dissolves in water; no increase in viscosity; rapidly and completely fermented (once fermented, the fiber is no longer present in stool, rapid gas formation, increased flatulence, energy harvest [calorie uptake] from fermentation by-products); may alter the numbers of specific bacteria in the gut (eg, "prebiotic" effect); no laxative effect at physiologic doses; does not gel or alter viscosity and thus does not provide any of the gel-dependent fiber health benefits. Readily fermented fibers are part of an emerging area of science relating to their effects on the gut microbiome, but to date, the marketed fiber supplements have no established clinically meaningful health benefits.
3. **Soluble viscous/gel forming, readily fermented** (eg, β-glucan [oats, barley], raw guar gum): dissolves in water, forms a viscous gel (eg, oatmeal), increases chyme viscosity to slow nutrient absorption and improve glycemic control, lowers elevated serum cholesterol, readily fermented (gas formation, energy harvest [calorie uptake] from fermentation by-products), fermentation results in loss of gel and water-holding capacity, and thus, no significant laxative effect and no retained gel to attenuate diarrhea.

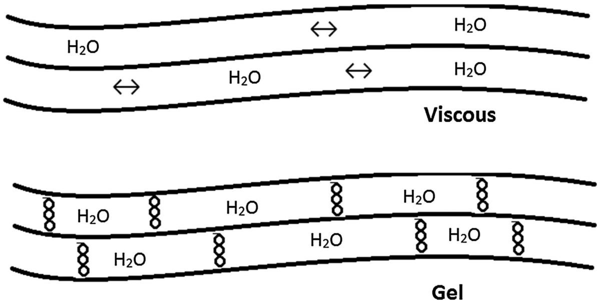

FIGURE 2. Viscous and gel-forming linear polymers. Drawings representing viscous linear polymers (top) and gel-forming linear polymers (bottom). Long-chain linear polymers orient parallel to adjacent fibers and increase viscosity in a concentration-dependent manner. Some long-chain linear polymers also can form cross-links that create a gel in a concentration-dependent manner (behave as a viscoelastic solid). Gel formation is an important driver of several metabolic health benefits for dietary fiber supplements, including cholesterol lowering, improved glycemic control, satiety, weight control, and stool normalization (soften hard stool in constipation and firm loose/liquid stool in diarrhea). (Drawings recreated with permission from John D. Keller, Jr, Keller Konsulting LLC, Freehold, NJ.)

4. **Soluble viscous/gel forming, nonfermented** (ie, psyllium): dissolves in water; forms a viscous gel; increases chyme viscosity to slow nutrient absorption and improve glycemic control, lowers elevated serum cholesterol; not fermented (no gas production, no calorie harvest from fermentation by-products); because it is not fermented, it remains gelled throughout the large bowel, providing a dichotomous "stool-normalizing" effect: softens hard stool in constipation (relieves/prevents constipation) and firms/forms loose/liquid stool in diarrhea (relieves/prevents diarrhea), and normalizes stool form in IBS.

SMALL INTESTINAL EFFECTS: IMPROVED GLYCEMIC CONTROL AND CHOLESTEROL LOWERING ARE GEL-DEPENDENT HEALTH BENEFITS

The small intestine is ≈7 m long and divided anatomically into 3 regions: duodenum, jejunum, and ileum. The mucosa of the small intestine is studded with millions of small villi, each covered with ≈1000 microvilli per 0.1 μm^2, making the small intestine the largest body surface exposed to the outside world (approximately 250 m^2, roughly the size of a tennis court).[3,16] Delivery of acidic nutrients into the duodenum (proximal small bowel) stimulates pancreatic secretions (inorganic = water, bicarbonate, and electrolytes; organic = digestive enzymes) as well as the release of bile from the gall bladder. The total quantity of fluid absorbed by the small bowel each day is a combination of fluids consumed (≈1.5 L/d) and the digestive juices secreted (≈6-7 L/d). In the fed state, the motor activity of the small bowel predominantly consists of segmental (mixing) contractions.[3,16] These segmental contractions mix chyme back and forth, exposing food particles to digestive enzymes and bile and facilitating exposure of digested nutrients to the absorptive brush border of the mucosa for absorption. Chyme, the liquid content of the small intestine, is normally very low in viscosity and is easily mixed with digestive enzymes for degradation and easily exposed to the villi for absorption of nutrients. The very large surface area of the mucosa normally results in efficient absorption of nutrients, which occurs early in the proximal small bowel.[3,16] Introduction of insoluble fiber (eg, wheat bran) or soluble nonviscous fiber (eg, inulin, wheat dextrin) has no significant effect on the rate of nutrient absorption in the small bowel because neither type forms a gel to alter the viscosity of chyme. In contrast, introduction of a soluble viscous, gel-forming fiber (eg, guar gum, psyllium, high-molecular-weight β-glucan) will significantly increase the viscosity of chyme in a dose-dependent manner, which will slow the mixing of chyme with digestive enzymes. This will lead to a slowing of the degradation of complex nutrients into simple, absorbable components and also slow turnover of chyme at the villi, all of which will slow the absorption of glucose and other nutrients.[3] This slowing of nutrient degradation and absorption lowers peak serum glucose concentration after a meal and delivers nutrients further into the small bowel for absorption. An effective gelling fiber can delay the absorption of nutrients long enough to deliver nutrients to the distal ileum, where they are not normally present. Nutrients delivered to the distal ileum stimulate mucosal receptors to initiate a cascade of metabolic responses, 1 of which is the release of glucagon-like peptide-1 into the blood stream. Glucagon-like peptide-1 is a short-lived (≈2-minute half-life) peptide that significantly decreases appetite, increases insulin secretion, decreases glucagon secretion (a peptide that stimulates glucose production in the liver), increases pancreatic β-cell growth (cells that produce insulin), improves insulin production and sensitivity, and slows gastric emptying and small bowel transit via a feedback loop called the "ileal brake" phenomenon.[3] All of the above metabolic responses are therapeutic targets for treating type 2 diabetes mellitus. Taken together, the sum of these phenomenon leads to a gel-dependent improvement in glycemic control for patients with type 2 diabetes and those at risk for developing the disease (eg, metabolic syndrome).[3,14,17–22]

SMALL INTESTINAL EFFECTS: SHORT-TERM AND LONG-TERM IMPROVEMENTS IN GLYCEMIC CONTROL ARE GEL-DEPENDENT HEALTH BENEFITS

There are 2 primary methods for assessing the effects of fiber supplements on glycemic control: an acute postprandial study and a long-term assessment of glycemic control. The acute postprandial test (glucose tolerance test) provides a glucose load (eg, 50 g glucose solution) with and without fiber supplementation. Blood glucose concentrations are drawn at frequent, predetermined intervals over a few hours to assess the rate of glucose absorption. Glucose is normally very rapidly absorbed in the most proximal region of the small intestine, resulting in a relatively fast rise in blood glucose and a high peak concentration. Because of a short lag in insulin response, this is typically followed by rapid decline in glucose with a transient excursion below the baseline level (Figure 3A, C). This transient hypoglycemia is caused by the lag in insulin response, which tends to stay elevated past the point where the blood glucose concentration has returned to baseline.

It has been established for more than 3 decades that the viscosity of a gel-forming fiber supplement is highly correlated with minimizing the high and low excursions of postprandial glucose. In a study published in 1978,[23] volunteers underwent glucose (50 g) tolerance tests with and without the addition of several fiber supplements, including guar gum. Native guar gum is a highly viscous, gel-forming fiber, and it exhibited a clinically meaningful decrease in both postprandial blood glucose and insulin concentrations. This beneficial response, however, was abolished when the guar gum was hydrolyzed to a nonviscous form, as is typically marketed today—partially hydrolyzed guar gum. The study showed that a reduction in postprandial blood glucose was highly correlated with the viscosity of a gel-forming fiber ($r = 0.926$; $P < .01$), as was a slowing of small bowel transit ($r = 0.885$; $P < .02$). Taken together, a high-viscosity, gel-forming fiber supplement (eg, raw guar gum, high-molecular-weight β-glucan, psyllium) can provide a clinically meaningful effect on elevated blood glucose level in a viscosity/dose-dependent manner, but nonviscous soluble fiber supplements (eg, wheat dextrin, inulin) do not provide a gel-dependent, clinically meaningful glycemic benefit.[1,3]

The second method, long-term assessment of glycemic control, entails multimonth, well-controlled, randomized clinical studies that assess a fiber's effects on glycemic control in the target population. These long-term studies provide evidence of a sustained effect and should be the standard for establishing a clinically meaningful therapeutic response for a given fiber supplement. Numerous multimonth (2–6 months) clinical studies have demonstrated that consumption of a soluble, gel-forming fiber supplement with meals can improve glycemic control (lowers fasting blood glucose, insulin, and hemoglobin A_{1c} concentrations) in subjects at risk for type 2 diabetes (eg, metabolic syndrome) and in patients being treated for type 2 diabetes.[1,3,24–38]

An example is an 8-week, placebo-controlled clinical study that evaluated psyllium (5.1 g BID) for improved glycemic control in 49 patients being treated for type 2 diabetes (fasting blood glucose and hemoglobin A_{1c} at baseline: psyllium group, 208 mg/dL and 10.5; placebo group, 179 mg/dL and 9.1).[38] After 8 weeks of treatment, fasting blood glucose for the psyllium group showed a significant decrease (−89.7 mg/dL; $P < .05$) versus placebo. Hemoglobin A_{1c} also showed a significant decrease (−3.0) versus placebo.[38] Note that the improvement in glycemic control observed with psyllium was above that already conferred by a restricted diet and stable doses of a sulfonylurea and/or metformin. The long-term effects of an effective gel-forming fiber on fasting blood glucose concentrations are proportional to baseline glycemic control: there is no significant effect on normal blood glucose concentrations in healthy subjects.[39] A moderate effect in patients with prediabetes and metabolic syndrome (eg, −19.8 mg/dL for psyllium 3.5 g BID; −9 mg/dL for guar gum 3.5 g BID),[26] and a larger effect in patients with type 2 diabetes (eg, psyllium, −35.0 to −89.7 mg/dL).[34,38] Note that gel-forming fiber supplements will not directly cause hypoglycemia (suppression of glucagon by glucagon-like

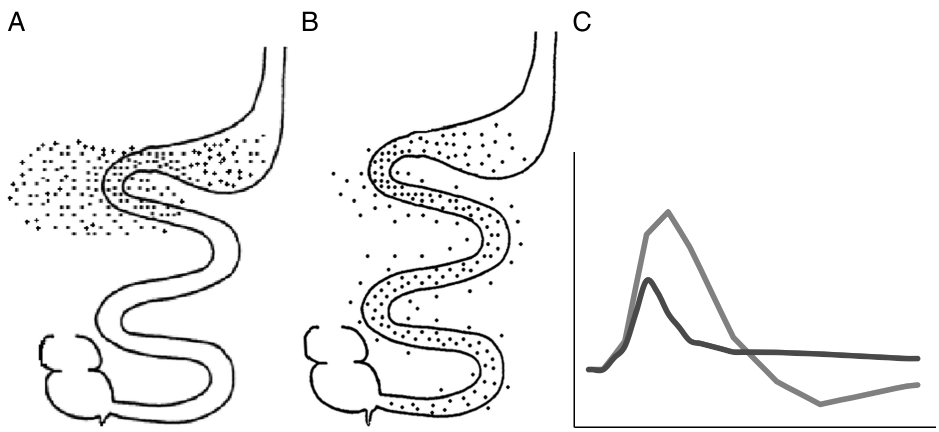

FIGURE 3. Absorption of nutrients in the small bowel is delayed by viscous fiber. Diagrams of nutrient absorption in the small bowel. Nutrients normally absorb very early in the proximal small bowel (A). Introduction of a viscous, gel-forming fiber (eg, guar gum, psyllium, high-molecular-weight β-glucan) can delay nutrient absorption to more distal regions of the small bowel (B). Rapid nutrient absorption (C: grey line, corresponds with A) is reflected by the higher peak concentration of blood glucose followed by a transient hypoglycemic trough below baseline. With the introduction of a viscous, gel-forming soluble fiber, the delay in nutrient absorption (C: black line, corresponds with B) results in an attenuation of glucose excursions: lower peak concentration of blood glucose, and attenuated hypoglycemic trough. (Drawings recreated with permission from Thomas Wolever, PhD, University of Toronto.)

peptide-1 does not occur at hypoglycemic levels), but for patients being treated for type 2 diabetes, fasting blood glucose should be closely monitored with the initiation of an effective fiber therapy as the fiber supplement may reduce the required dose of hypoglycemic drugs.

SMALL INTESTINAL EFFECTS: CHOLESTEROL LOWERING IS A GEL-DEPENDENT HEALTH BENEFIT

It is well established that reducing elevated serum low-density lipoprotein (LDL)-cholesterol concentration reduces the risk of coronary artery disease.[40] It has been estimated that a 1% reduction in LDL-cholesterol concentration reduces the risk of coronary artery disease by 1.2% to 2.0%.[41] Similar to the gel-dependent nature of improved glycemic control with fiber supplements, lowering elevated serum cholesterol concentrations is also a gel-dependent phenomenon in the small bowel, and the effectiveness of cholesterol lowering is highly correlated with the viscosity of the gel-forming fiber: The higher the viscosity of a gel-forming fiber is, the greater the effect on lowering elevated cholesterol concentrations.[37] Clinical studies have shown that the viscosity of a gel-forming fiber is actually a better predictor of cholesterol-lowering efficacy than is the quantity of fiber consumed.[42] The primary mechanism by which gel-forming fibers lower serum cholesterol is by trapping and eliminating bile. Bile is secreted by the liver (normally 600–1000 mL/d) to emulsify large fat particles into many small particles for digestion by lipase enzymes and absorption across the mucosa.[16] Bile is normally highly conserved, recovered in the distal ileum, and recycled up to several times within a single meal. When bile is trapped in a gel-forming fiber and eliminated via stool, the liver must produce more bile to meet digestive needs. Cholesterol is a component of bile, and the liver uses serum stores of cholesterol to generate more bile, effectively lowering serum LDL-cholesterol and total cholesterol concentration, without affecting high-density lipoprotein cholesterol.[43]

To assess the importance of viscosity for a gel-forming fiber in lowering elevated serum cholesterol concentration, a clinical study compared the cholesterol-lowering effects of a medium-viscosity blend of gel-forming fibers (psyllium, pectin, guar gum, and locust bean gum) with those of an equal amount (three 5-g servings per day for 4 weeks) of low-viscosity gum Arabic (Acacia gum, highly branched) in 26 patients with hypercholesterolemia.[44] The medium-viscosity gel-forming blend exhibited a 10% reduction in total cholesterol concentration ($P < .01$) and a 14% reduction in LDL-cholesterol concentration ($P < .001$), with no significant change in high-density lipoprotein or triglyceride levels. In contrast, the low-viscosity gum Arabic-treated group showed no change in any plasma lipid characteristics.[44] A second publication with 4 studies (duration 4–12 weeks) explored the plasma lipid-lowering effects of a variety of soluble dietary fibers.[45] The studies were randomized, double-blind, placebo-controlled trials involving men and women with hyperlipidemia (plasma cholesterol >200 mg/dL). Low-viscosity gum Arabic (acacia gum) (15 g/d for 4 weeks) did not produce a significant lipid-lowering effect versus placebo. In contrast, 15 g/d of a medium-viscosity blend of soluble fibers (psyllium, pectin, guar gum, and locust bean gum) consumed for 4 weeks yielded significant reductions in total cholesterol (8.3%) and LDL-cholesterol (12.4%) concentrations ($P < .001$), similar to the 10 g/d high-viscosity raw guar gum. The lipid-lowering benefit of the medium-viscosity blend of soluble fibers (psyllium, pectin, guar gum, and locust bean gum) also showed a dose-response effect for reducing LDL-cholesterol concentration: placebo, +0.8%; 5 g/d, −5.6%; 10 g/d, −6.8%, and 15 g/d, −14.9% (all doses $P < .01$ vs placebo). The effects of the gel-forming fibers on plasma lipids were similar for both men and women. The authors concluded that the findings support the usefulness of medium- and high-viscosity gel-forming fibers as a cholesterol-lowering therapy but cautioned against ascribing cholesterol lowering benefits solely on a classification of solubility.[45] As with improved glycemic control, the viscosity of the gel-forming fiber is the key driver of efficacy for lowering cholesterol in patients with hyperlipidemia.

Also similar to the gel-dependent effect glycemic control, the potential for a cholesterol-lowering benefit is highly influenced by the baseline cholesterol level: Gel-forming fibers have no appreciable effect on cholesterol concentrations in healthy subjects with normal cholesterol concentrations but exhibit a progressively greater benefit as baseline cholesterol exceeds normal concentrations. The cholesterol-lowering benefit of gel-forming fiber supplements is observed in addition to the benefits conveyed by the prescription drugs in patients already being treated for hyperlipidemia. Eight clinical studies have shown that a gel-forming fiber (psyllium) enhanced the cholesterol-lowering benefit of prescription drugs when dosed as a cotherapy to statin drugs and bile sequestrants.[46–53] There are only 2 fiber supplements approved by the Food and Drug Administration to claim a reduced risk of cardiovascular disease by lowering serum cholesterol: β-glucan (oats and barley) and psyllium, both gel-forming fibers.[54]

An effective gel-forming fiber supplement can actually lower the required dose of a prescription statin drug. For example, in a 12-week randomized, double-blind study including 68 patients with hyperlipidemia, a low dose of simvastatin (10 mg) combined with psyllium (15 g/d, divided doses before meals) was superior to the low dose of simvastatin alone (−63 vs −55 mg/dL, respectively; $P = .03$) and identical to a high dose of simvastatin alone (20 mg, −63 mg/dL) for lowering elevated serum LDL-cholesterol concentration.[55]

Gel-forming fibers can provide an effective cotherapy for hypoglycemic and cholesterol-lowering drugs to help reduce required doses and potentially reduce side effects. As described above, low-viscosity fibers (gum Arabic/acacia

TABLE Clinically Demonstrated Health Benefits Associated With Common Fiber Supplements

	No Water-Holding Capacity			Water-Holding Capacity			
	Insoluble	Soluble, Nonviscous		Soluble Viscous	Soluble Viscous/Gel Forming		
	Wheat Bran	Wheat Dextrin	Inulin	Methylcellulose	Partially Hydrolyzed Guar Gum	β-Glucan	Psyllium
Source	Wheat	Heat/acid treated wheat	Chicory root	Chemically treated wood pulp	Guar beans	Oats, barley	Seed husk, *Plantago ovata*
Degree of fermentation	Poorly fermented	Readily fermented	Readily fermented	Nonfermented	Readily fermented	Readily fermented	Nonfermented
Cholesterol lowering					+/−[a]	+[b]	+
Improved glycemic control					+/−[a]	+[b]	+
Satiety						+[b]	+
Weight loss							+/−[c]
Constipation/ stool softener	+[d]			+/−[e]			+
Diarrhea/stool normalizer							+
Irritable bowel syndrome							+[f]

Blank cells indicate a totality of negative clinical data or a lack of clinical data supporting the health benefit.

[a]The efficacy of partially hydrolyzed guar gum depends on the degree to which it has been hydrolyzed. If a marketed product has little/no viscosity when mixed with water (as described above), then it will not exhibit significant gel-dependent health benefits.

[b]Oat products are typically marketed in fiber bars or cereals, requiring pressure and/or heat to make the final product, potentially reducing gel-forming capacity.

[c]The criteria for ''clinically demonstrated'' was publication of at least 2 well-controlled clinical studies. Sustained weight loss for psyllium was assessed in only 1 clinical study,[11] so a designation of +/− was deemed most appropriate.

[d]Insoluble fiber can have a significant laxative effect if the particle size is sufficiently large/coarse.

[e]Methylcellulose has an over-the-counter (OTC) indication for treatment of occasional constipation, but the American College of Gastroenterology determined that methylcelluose had insufficient clinical data to recommend it for treatment of chronic constipation.

[f]A recent comprehensive review published in the *American Journal of Gastroenterology* determined that ''When fiber is recommended for functional bowel disease, use of a soluble supplement such as ispaghula/psyllium is best supported by the available evidence.''

gum, methylcellulose) and nonviscous supplements (eg, inulin, wheat dextrin) do not exhibit a cholesterol-lowering benefit.[37,44,45,56,57]

CONCLUSIONS

Despite a general consensus that fiber is "good for you," it is important to recognize the difference between replacement with dietary fiber that is intrinsic and intact in whole foods and supplement with an isolated fiber source. Fiber supplements cannot be presumed to have the same health benefits that are associated with dietary fiber that is intact and intrinsic in whole foods. The clinically proven health benefits for fiber supplements are associated with specific characteristics (eg, viscous gel), and only a minority of marketed fiber products provide health benefits (summarized in the Table). Health benefits associated with fiber effects in the small bowel (eg, cholesterol lowering, improved glycemic control, satiety, weight loss) are a gel-dependent phenomenon, and the degree of benefit is proportional to the viscosity of the gelling fiber. Health benefits associated with fiber effects in the large bowel (eg, relief from constipation, diarrhea, IBS) will be discussed in detail in part 2 of this 2-part series. Briefly, large bowel effects are derived from 2 mechanisms: An insoluble fiber provides a mechanical stimulus proportional to particle size (eg, wheat bran—softens hard stool in constipation but can exacerbate diarrhea and IBS) and a nonfermented gel-forming fiber that remains intact/retains its high water-holding capacity throughout the large bowel can provide a stool-normalizing effect (ie, psyllium—softens hard stool in constipation, firms loose/liquid stool in diarrhea, normalizes stool form in IBS). When recommending a fiber supplement, only a soluble nonfermenting, gel-forming fiber has been clinically proven to provide all of the health benefits typically associated with a fiber supplement.

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