Durk Pearson & Sandy Shaw's 21st Century Weight Loss Program

How the use of a special barley flour or flakes can promote weight loss by lowering the glycemic index of many foods

Glycemic Control Interview: Part 1 of 2

B*ack in 1986, Durk & Sandy wrote a book called* The Life Extension Weight Loss Program, *which hit the bestseller list. Unfortunately, the budget for publicity tours was cut, and the book never got the promotion that was promised—not formally, at least. But its impact on the use of nutritional supplements for weight loss was phenomenal: it created a market where none had existed before. Of the ideas introduced by Durk & Sandy, the one that caught fire and rose to dominate the market was* stimulated thermogenesis, *a process by which one could increase the rate at which the body burns fat.*

Now, 20 years later, Durk & Sandy have again given the subject the benefit of their research and hard thinking to create a new program, one especially suited to the times of our lives and the world as it is. The interview that follows (the first of a two-part product series) will introduce a weight loss strategy based on the concept of glycemic control. It's designed to revolutionize the way you eat and to improve your health, without the need for calorie counting or even exercise—and without giving up the pleasures of eating!

— WILL BLOCK

LE: Durk, tell us about your weight loss success.

DURK: We're introducing a new **glycemic control weight loss program,** a protocol that has helped me lose a lot of weight. At the outset, I weighed 234 pounds, but after about 7 1/2 months, I'm down to 203 and still dropping. During that time, I've never gone hungry, I haven't done any significant exercise (although exercise is undeniably good for you), and I haven't counted calories. There are, of course, certain "downsides" to losing weight: I keep having to buy smaller-size blue jeans, and I even had to buy a smaller gun belt for when I carry my .44 magnum out at the ranch.

Anyway, the program involves a change in diet, where you start by selecting foods with a low *glycemic index.* That's a numerical rating system for carbohydrate-containing foods, based on how they affect your blood glucose levels after you consume them. It's not a theoretical index, but one based on actual measurements in humans.

An example of a low-glycemic food is sweet potatoes, which our program would substitute for white russet baking potatoes. It also entails the use of a special strain of **barley flour** (or, alternatively, **barley flakes**—and let's agree that from here on, when we talk about the flour, we'll be referring to the flour and the flakes). What's special about this barley flour is that it contains very high levels of *beta-glucan*, a soluble, viscous fiber that slows down the absorption of foods it's mixed with—a truly amazing effect. When you add the barley flour to almost any food, *it will lower the glycemic index.* That turns what you eat into *time-released food.*

SANDY: Because weight loss is a complex subject, we're going to do a series of interviews on it. In this one, we'll discuss what makes you fat and then explain how you can reduce the amount of fat on your body. We've found that lowering the glycemic index of what you eat can help reduce your weight by altering the effect that food has on your body and by reducing the amount that you eat.

In the next interview, we'll discuss the bulk of the experimental data pertaining to the glycemic control strategy, part of our 21st century weight loss program, which is fundamentally associated with the *rate* of glucose absorption as well as the overall *caloric energy balance* involved. A key point is that resting metabolism drops when glucose is low, so when people reduce calories by dieting, the drop in resting metabolism makes it hard to lose weight. The time-release factor is important as the impetus for helping to prevent this undesirable effect, but much more important is the idea that it causes (or can cause) a person to *eat less.* Also, however, a slow glucose release permits more to be burned, leaving less to be converted to body fat. Resting metabolic rate is not invariable, even without the use of thermogenic agents.

How You Get Fat

DURK: If you understand why you get fat, it'll be a lot easier for you to do something about it without the pain. When you sit down to a holiday feast and start digging into that yummy russet baked potato in front of you, what happens? Why does it make you fat?

When you eat a baked potato, its starch gets depolymerized in your gut by an enzyme called alpha-glucosidase, turning it into glucose. The glucose is quickly transported through your intestinal wall and is absorbed into your bloodstream. Your blood sugar goes sky-high.

SANDY: In fact, the russet baked potato actually has a glycemic index nearly as high as that of pure glucose, and it's typically about 50% higher than the much lower glycemic index of pure sucrose (cane or beet sugar), although it can be close to 100% higher, depending on the source of the potatoes and other variables. Thus, if you eat 100 grams of baked potato, you might as well be ingesting almost 100 grams of glucose in a glucose tolerance test. Your glucose level spikes, and your body reacts by releasing a lot of insulin to prevent hyperglycemia.

DURK: Some of the excess glucose in your blood will be converted to glycogen, a glucose polymer that's stored in your liver for quick conversion back to glucose on demand. Between meals, a substantial amount of that glycogen is released as glucose to fulfill the ongoing needs of your body's cells, even if you're not an active, athletic type. Obese people appear to store large amounts of glycogen that undergo major fluctuations during the day. This suggests that, for the obese, glycogen is a critical source of cellular fuel—and that makes it hard for them to burn the fat they're storing.

That fat got stored in the first place owing to excessive caloric intake, especially when it was absorbed too quickly. If there's more glucose in the blood than the cells need, and if the liver is full of glycogen, which occurs soon after a meal, the fate of the excess glucose is pretty much sealed: it gets converted to fat and stored in fat cells. Unlike glycogen, fat can never be converted back to glucose—it can only be stored or burned.

LE: Wasn't substantial fat storage necessary for survival in the past?

DURK: Yes. Back in the Ice Age, few people grew old—it's estimated that only 1 or 2% even reached 40. Becoming obese was not in the cards, but having a nice, thick layer of fat on your body provided good insulation against the winter cold, as well as a life-saving source of fuel when food was scarce. Just ask any polar bear, seal, or whale about the virtues of blubber.

Glycemic Control—The New Gold Standard

DURK: Our glycemic control weight loss program is a powerful tool for creating healthier, lower-glycemic foods while eating what you like. It's based on the special barley flour, which has about twice the beta-glucan of regular barley and about three times as much as oats. Oats are generally considered to be the gold standard of low-glycemic, high-solubility, viscous-fiber foods, so we're going to be comparing our barley flour and flakes with oats.

SANDY: Back in the 1990s, we had a product made from a strain of barley that was selected for its high content of beta-glucan. Unfortunately, the manufacturer dropped it. But the barley we're using now has about twice the beta-glucan of the original. It's derived from a native strain found in an area of the Himalayas around Tibet, Nepal, and India; it was extremely high in beta-glucan to begin with and was selectively bred to be even higher.

Comparing our barley flour to oatmeal, a study in *Plant Foods for Human Nutrition* in 2005 found a remarkable difference.[1] In nondiabetics, the rise in glucose was only 15.5% (one-seventh as much) for the barley flour as compared with the oatmeal; in diabetics, that figure was 35%. For insulin, the corresponding figures for barley flour compared with oatmeal were 29% in nondiabetics and 32% in diabetics.

Clearly, our barley flour is a very low-glycemic food. In fact, if you look at the glycemic index (GI) of our barley flour alone as a hot cereal—with glucose being 100, white bread 70, whole-grain bread 59, and hot cereal oats 51—it comes in at 25. This is comparable to some lentils, many of which have GI values in the 20s.

Creating Time-Release Food

DURK: If you add some of the barley flour to lentil soup—and we've come up with a delicious version of it (see the sidebar)—the results are amazing. I didn't feel like eating anything else for 24 hours. And if you don't feel like eating, it's easy *not to get fat*, and it's easy to *lose weight*. By adding our barley flour to lentil soup, we transformed something that was low in glycemic index to something even lower, turning it into a carbohydrate time-release type of food.

An article from *Cereal Chemistry* in 1997 makes the time-release case.[2] While pasta is moderately low in glycemic index for a carbohydrate-rich food, in this study plain pasta showed a significant blood sugar rise. However, just by replacing part of the wheat flour with the barley flour—the same one we're using—the blood sugar rise was almost statistically insignificant, and it went on hour after hour. The insulin rise was much lower too.

Cholecystokinin is a hormone produced in your gut. It signals your brain, "I'm full; I'm not hungry anymore, so I don't need to eat." It's a satiety hormone. In a 1999 study done with regular pasta, cholecystokinin was elevated for about 3 hours after a meal.[3] But using a pasta in which some of the wheat flour had been replaced with the same barley flour that we're using, they found that the cholecystokinin was elevated for 6 hours—twice as long.

LE: What other effects can the high beta-glucan in barley flour provide?

SANDY: Beta-glucan has remarkable effects on the amount of the carbohydrates that you digest. In another article published in the *Journal of Nutrition* in 2002, researchers compared the digestion of regular barley with that of our naturally beta-glucan-rich barley.[4] They found that humans absorbed less glucose from the special barley than from the regular barley, because more of the former remained undigested and wound up in the colon. There it was fermented by intestinal bacteria, producing short-chain fatty acids, which are very healthful; they also help make you feel full.

Also of interest in the cholecystokinin study mentioned above,[2] the scientists found that the beta-glucan in the barley inhibited absorption of cholesterol from the meal, but it also apparently stimulated reverse cholesterol transport, a process in which cholesterol is removed from arteries and excreted. This may contribute to barley's cholesterol-lowering ability.

Barley is not, however, a substitute for statins in this regard. On the other hand, if you eat meals enriched with the special barley flour, you may not need drugs to reduce cholesterol. The barley flour is capable of lowering cholesterol. In fact, the FDA actually allows a cardiovascular claim for the use of barley fiber.

DURK: To qualify, the amount of soluble fiber in the barley product must be a mere 0.75 gram per daily serving; at 30% soluble fiber, that means 2.5 grams per day of our barley flour product. This is less than oatmeal, because there's three times as much of the beta-glucan in the special barley.

The way the claim reads is, "Soluble fiber from foods such as [product name], as part of a diet low in saturated fat and cholesterol, may reduce the risk of heart disease. A serving of [product name] supplies more than 0.75 gram of the soluble fiber necessary per day to have this effect."

LE: How else can one use your glycemic control weight loss strategy?

SANDY: The special barley flour can be added to almost any type of meal that you like. You can add it to soup, for example, either before or after cooking it. It will thicken the soup like a starch would—after all, it is a barley starch. But a regular starch will be broken down almost immediately, causing a blood sugar and insulin spike, with much of that glucose ending up as body fat. By contrast, the special barley starch will meter out glucose from the soup over an extended period of time. Starch, incidentally, constitutes only about 30% of our barley flour; the rest is mostly beta-glucan fiber and protein.

Universal Method for Lowering the Glycemic Index

DURK: Now, if you're going to be sitting at someone else's holiday table and you weren't involved in preparing the feast, all you need do is take a glass of something like milk or fruit juice and mix a couple of tablespoons of our special barley flour into it. Then, by drinking it before you start eating, your holiday meal will turn into a time-release meal.

SANDY: By the way, it's still better to eat a sweet potato than a white russet potato. We're now enjoying sweet potato French fries—we both love French fries. The only trouble is, the white potatoes have a very high glycemic index. Although the GI of those fries is lower than that of the corresponding unfried potatoes (because fat retards the rate of digestion), it's still high. You can, of course, fry the potatoes in a healthful fat, such as a high-oleic sunflower oil, or you can bake them in the oven and avoid the fat altogether—but either way, the GI will be high.

So Durk and I are using sweet potatoes instead, because they have a much lower GI. Plus, they're a great source of fiber, and they taste wonderful—even better than conventional fries. And by drinking a beverage with a couple of tablespoons of our barley flour, you can lower the GI even further. This is a universal method for lowering the glycemic index of your food.

Around this time of year, you're not likely to be exercising as much as usual, but you're still sitting in a heated office or home, moving your fingers and eyes while looking at your computer screen—that may be the extent of your exercise. And then there's all that delicious food calling out to you. Under these circumstances, our special barley flour comes to the rescue, and it does so with almost any type of food you like. It's so easy to add to your diet.

LE: What else can your special barley flour do?

DURK: The beta-glucan it contains is picked up by macrophages, a type of white cell of your immune system, and broken down. The fragments are presented to other white cells, which are then activated, and those activated white cells have been found to attack bacteria and virally infected cells in experimental animals. It also stimulates your immune system to attack cells infected by various viruses, including the swine flu, and a variety of bad bacteria, while at the same time encouraging the growth of good bacteria, such as *Lactobacillus,* in your colon.

LE: Could you say that it feeds your immune system?

DURK: Yes, it literally does feed it. It's a dietary supplement for your immune system as well as for your cardiovascular system. So this is really a win-win situation. And it's very easy to employ.

Of course, the more you lower the glycemic index of your meals through judicious food choices, the better it will work. Even if you eat a high-glycemic food, simply adding the special barley flour can lower the glycemic index. So you end up with the benefits, but with less fat, lower glucose levels, and reduced insulin release. High glucose and high insulin are both dangerous by themselves, quite apart from their ability to increase body fat.

LE: How much of the special barley flour would one have to use to get the kinds of benefits you're talking about?

DURK: I use about six tablespoons a day. When I have a glass of orange juice or a bowl of cereal in the morning I mix in a couple of rounded tablespoons. At lunch I take two more, and when I have dinner, I have another two. This has resulted in my dinners being considerably smaller than they used to be, which is one of the reasons my weight continues to drop.

Now, there are other reasons as well, and we'll be discussing those in the next interview. We have a couple of additional new dietary supplements that will work with our glycemic control weight loss program. There are multiple reasons why people get fat as they get older, and there isn't just one silver bullet that's going to cure it.

SANDY: I like adding three or four tablespoons of the barley flakes to a high-protein, reduced-sugar cereal. Remember that the barley contains 18% protein, almost as much as meat. Moreover, like meat but unlike most cereal proteins, it's high in lysine, so it has a high available-protein-use efficiency.

Our built-in genetic program for storing excess energy as body fat is so strong that it takes a range of strategies to circumvent it. One way is to keep the glycemic index of foods down as low as possible. And our glycemic control weight loss program is a universal method for doing that.

Let me stress, though, that if you choose lentils rather than baked potatoes to begin with, you'll be better off, especially if you add our special barley flour. But if you really like vichyssoise (potato soup), by all means add the barley flour to it—it will reduce what would otherwise be a very high glycemic index.

Our special barley flakes make a great breakfast cereal, either alone or mixed with your favorite grain. And the barley flakes are also a wonderful addition to meat loaf, casseroles, turkey stuffing, and lots of other yummy foods.

References

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Sandy’s Lentil Soup

This soup is delicious, full of healthful fiber, and easy to make.
For about 6 servings, you will need:

2 cups	lentils
1	carrot, cut into 1-inch pieces
1	medium red onion, chopped
6 cups	fat-free chicken broth
2 tbsp	butter
1 tsp	ground cumin
1 tsp	ground coriander
1 tsp	ground ginger
1/2 tsp	freshly grated nutmeg
1/2 tsp	ground allspice
1/4 tsp	cayenne pepper
	salt and freshly ground black pepper to taste
3 tbsp	fresh lemon juice (about the juice of one whole large lemon)
6–12 tbsp	barley flour or flakes
4 tbsp	chopped cilantro

In a large saucepan, cover the lentils, carrot, and onion with the chicken broth and bring to a boil. Simmer until the lentils are tender but not mushy, about 25–30 minutes.

Add the butter and spices (but not the lemon juice and cilantro) and cook, stirring, for about 5 minutes. Then add the salt (if desired) and black pepper, and the lemon juice.

Serve immediately. After dispensing the soup into serving bowls, add 2 rounded tablespoons of the barley flour or flakes (or 1 rounded tablespoon if you prefer less of the barley’s grain taste) and mix in. Finally, sprinkle a generous portion of chopped cilantro on top.

Variation: For a meat-containing soup, add desired quantity of chopped, low-fat, smoked turkey or ham to the soup when you add the butter and spices.

Durk Pearson & Sandy Shaw's 21st Century Weight Loss Program

More on the use of special barley flour, quick flakes, or nuggets to promote weight loss by lowering the glycemic index of many foods

Addendum to Part 1 of the Glycemic Control Interview

The interview with Durk Pearson & Sandy Shaw on Glycemic Control (Part 1 of 2) that appeared in the December 2006 issue was abbreviated owing to technical problems with the recording. Consequently, this is an addendum to that interview to cover the missing parts. A more technical article by Durk and Sandy appears in this issue on page 7. It includes the scientific references for their conclusions about glycemic control, what it means, and how you can benefit from it.

— WILL BLOCK

Durk: It's important to understand that our conclusions about glycemic control are based on a significant amount of research—explaining what it does and why it does it—because the benefits go far beyond weight control. That's of considerable importance, especially to someone like me.

Sandy: Weight control is not the only reason for using our special barley. It also decreases glucose levels in the bloodstream—an important part of improved health—and it may even increase lifespan. The mechanisms underlying caloric restriction and other methods, such as certain genetic manipulations that increase lifespan in mammals and other animals, are not yet fully understood. But it's clear that reducing blood glucose levels and hence reducing oxidative stress, glycosylation, cross-linking, and especially the activity of the insulin/IGF signaling pathway, are key features of life extension.*

*See Gems D, Partridge L. Insulin/IGF signalling and ageing: seeing the bigger picture. *Curr Opin Genet Dev* 2001 Jun;11(3):287-92.

Durk: Even if you're not fat and you want to extend lifespan, one method that has been shown to work well in animals (it would probably benefit humans as well) is caloric restriction. Unfortunately, though, it has certain disadvantages. The first and biggest one is that every animal has the instinct to avoid starvation, especially when there's food around. So if you're going to starve yourself and be hungry for the rest of your life, you're not going to have a very happy life, even though it may last longer.

Sandy: There are unpleasant side effects to caloric restriction too, but they're rarely discussed in the popular literature. At scientific conferences, we've talked to people who've worked with calorically restricted animals. They've told us that calorically restricted monkeys—which are the closest species to humans that have been calorically restricted over a lifetime—are nasty, mean, and irritable. These animals are always like that, and that's not a quality of life that most humans would find agreeable.

Durk: Our approach, however, does not involve caloric restriction. It involves lowering glucose levels, particularly peak after-meal glucose levels, which can be done quite dramatically. It does *not* entail being hungry all the time, so you're not fighting millions of years of instincts.

Sandy: In fact, it doesn't involve being hungry at all.

Durk: So far, I've lost 37 pounds: I'm down to 197 from a high of 234. A few weeks ago, I thought I had hit a plateau at about 200, but this morning I weighed in at 197, so apparently I'm still losing. My abdominal fat, using the well-known "pinch test," is around 5/8 inch. I'm within 9 pounds of the weight I was back in 1980, and if you look at photographs of me now compared to then, I've got a lot more muscle.

Sandy: Essentially, there are three techniques involved. The first and most important step is to choose low-glycemic-index foods. You might want to acquire *The New Glucose Revolution* [available from Life Enhancement Products]. And one way that you can lower the glycemic index of food even more is through the use of our special barley, which we discussed extensively in the December 2006 interview. That's how Durk started.

LE: How much weight did you lose just by lowering the glycemic index of what you eat?

Durk: Before we started using our special barley, just by going to an Atkins-type diet with additional fiber from regular food sources, I went from 234 to about 224. Since adding the barley for glycemic control and a couple of other techniques (which we'll be talking about in subsequent interviews), I've dropped down to 197, and apparently it hasn't stopped yet.

Sandy: The first technique also employs the use of resistant starch and erythritol in cooking, instead of sugar, to help decrease the glycemic index of foods.

Durk: We mentioned these additional foods in Part 2 of our Glycemic Control interview, in the January 2007 issue. In the article on page 7 of this issue, in which 20 literature citations are given, we provide many quantitative details, focusing on such questions as (if you're a type 2 diabetic): How much can you expect your insulin and blood sugar levels to be reduced after a meal? Also (if you're *not* a type 2 diabetic): How much lowering of insulin and blood sugar can you expect? And: What does this mean?

Sandy: There's also information comparing the benefits of barley vs. oatmeal in terms of reduced glucose and insulin levels. Until now, oats have been the gold standard of high-fiber grain, but the barley we're using contains three times as much soluble fiber as oatmeal and has consequently proved to be more effective at reducing glycemic index.

Durk: In fact, our barley has so much soluble fiber that it qualifies for the FDA's cardiovascular health claim with only a little over half a teaspoon (not tablespoon!). So the amounts we're recommending—6 rounded tablespoons of barley per day—provide a significant amount of protection.

It's important to stress that glycemic control is at the foundation of our program and that the additional techniques we'll be discussing in subsequent interviews do not work on a regular-glycemic-index diet. Alone, the glycemic control products will help you lose weight without hunger, but if you try the additional techniques (involving yet-to-be-announced products you'll be reading about in the coming months) and don't do anything to lower your glycemic index, you'll be disappointed, and you'll be wasting your money. It is literally impossible for them to work on a regular-glycemic-index diet.

Sandy: There are complex regulatory pathways that control how much you eat, what you eat, and when you eat. These pathways are critically dependent on the content of what you eat and how that affects the amount of glucose in your bloodstream. When you add our glycemic control barley to your diet, it will have a strong effect on your regulatory pathways, because your glucose levels will be lower, and that's one of our most important goals.

Durk: It's interesting to note that the food in our low-glycemic-index diet is really much closer to what our evolutionary predecessors ate over the past million years or so. Modern food products are very different from what our ancestors ate 1000 years ago, let alone 10,000 or 100,000 or a million years ago.

Sandy: The vegetables and brans consumed back then contained a great deal more fiber than the sorts of highly domesticated, highly refined products that have been developed for human consumption in the present.

Durk: Although humans have been grinding grain for at least 10,000 years, the primitive tools they used did not produce a refined, powdered product—all the fiber was carried over into the food. Consequently, the absorption of glucose was dramatically slowed down. With a coarse grind, there's not as much surface area of the grain's starch exposed to the alpha-glucosidase enzyme, which breaks it down into glucose and allows it to enter the bloodstream. Accordingly, over the last 10,000 years, people were eating time-released food. Our glycemic control product line of beta-glucan-rich barley and resistant starch is a return to what we used to have throughout almost all of our evolutionary history.

Sandy: Mixing our barley with regular food turns it into time-release food, which slows down digestion and slows the absorption of the glucose and the fats in food.

Durk: It also causes reverse cholesterol transport. Your liver converts cholesterol to bile salts, which help emulsify and break down fats so they can be absorbed. The bile is released from the gallbladder through your bile duct and ends up in the lumen of your gut. With beta- glucan-rich soluble fiber, such as our special barley, bile salts get trapped and end up being excreted in your feces. Of course, this means that your body has far less cholesterol and bile salts. Normally, bile salts are reabsorbed and reused.

When you lose bile salts, your liver generates more HDL-cholesterol, which removes cholesterol from your tissues, including amounts that are bound in atherosclerotic plaque. This is called reverse cholesterol transport. The cholesterol is delivered to the liver, where it eventually gets turned into bile. And where does it go? It goes down the toilet.

Sandy: We hope you'll enjoy reading the additional article on our special barley on page 7, and we hope that you'll try it.

Durk: Again, it's a technical article, but a worthwhile read. If you think you're going to lose weight by taking some magic pill, forget about it—they either don't work or they pose significant dangers for the people who need weight loss the most, such as those who are obese and hypertensive. Our program can be used safely by people who are obese, hypertensive, hypercholesterolemic, diabetic, etc. We have no warnings on it because anyone can use it.

LE: Isn't the message worth repeating?

Durk: Yes. I've gone from 234 to 197 with zero hunger—no hunger at all, ever.

Sandy: And without calorie counting.

Durk: Right. I eat when I want, although I'm careful about what I eat. I eat a huge amount of meat and fish and so forth, and a lot of barley, let me tell you.

Sandy: A meal without barley is not a meal that matters. And if you take the barley flour when you go to a restaurant, you can turn a high-glycemic-index meal into something that's considerably lower in glycemic index.

Durk: That's right. A big problem when you go to a party or to a restaurant is that you have no control over the food. You usually face a meal that's chock full of easily digestible carbohydrates and sugars, which can be a real dilemma. But if you bring your barley flour (don't leave home without it!) and use it as a supplement while you're eating your food, it will help you achieve a reduced-glycemic-index food or meal.

Sandy: You simply add a couple of rounded tablespoons of the barley flour to a glass of water, mix it up, and drink it during the meal. Don’t drink it beforehand—it will be quickly released into your small intestine and will be less likely to affect the food that you eat later.

Durk: The key is to mix the barley with the water and drink it *during* the meal to ensure that it doesn’t precede the meal through your stomach and beyond. You could drink it at the end of the meal—that would be fine—but don’t wait several hours, because by then your stomach will have discharged its contents into the small intestine.

Sandy: You don’t have to die hungry.

Durk: You don’t have to die hungry to live a long time. [Laughter]

Durk Pearson & Sandy Shaw's
21st Century Weight Loss Program

How the use of resistant starch and erythritol can promote weight loss by lowering the glycemic index of many foods and avoiding many of sugar's negative consequences
Starch foods can be more filling and a lot less fattening.
You don't have to give up a sweet tooth!

Glycemic Control Interview: Part 2 of 2

Last month, Durk and Sandy explained how the use of naturally beta-glucan-rich barley can help promote weight loss by lowering the glycemic index of many foods. This month, they add to their strategy for glycemic control by introducing two new glycemic-control foods: one a high-resistant starch and the other a low-calorie natural sweetener.

The overall idea of Strategy #1 (Glycemic Control) of their weight loss program is to change the way you eat by substituting lower-glycemic-index foods for some of your food choices and adding glycemic-control foods to your diet. Doing so will enable you to reduce the negative effects of high-glycemic-index foods on your health, by lessening the glucose available to feed your fat cells, while simultaneously reducing your fat levels. You'll never need to go hungry or suffer the boredom of a bland diet—and you won't have to give up your sweet tooth!

— WILL BLOCK

LE: Now that we know all about your special barley products, what's next?

DURK: We're adding two more foods to our glycemic control system. One is a special **resistant starch,** and the other is the sugar alcohol **erythritol.** These foods are very useful to help control your glucose (blood sugar) and improve your insulin sensitivity—essential considerations if you want to reduce the amount of fat your body synthesizes.

Scientific studies have shown that consuming a meal high in resistant starch decreases peak glucose and insulin concentrations as well as the total amount of glucose absorbed. As we explained in last month's interview**,** these benefits can also be achieved by using a good soluble fiber, such as **beta-glucan.** The two barley products we introduced then—flour and quick flakes—are naturally rich in beta-glucan. This month we're adding two more barley products to the list: whole flakes and nuggets.

SANDY: Resistant starch works differently than barley, so it needs to be discussed separately. Because of its soluble fiber, barley impedes the diffusion of nutrients through the lumen of your gut (i.e., diffusion down the intestinal "pipeline," not through the intestinal walls).

DURK: Starch is a complex carbohydrate used by plants to store excess glucose. Resistant starch is a starch that resists digestion in the small intestine, where most ordinary starches are quickly broken down into glucose. Resistant starch proceeds to the large intestine, where some of it is fermented and where it causes an increase in the production of short-chain fatty acids, such as acetate, propionate, and butyrate. Much of it ends up (ends down?) being excreted, because it's not there long enough to be digested by intestinal bacteria.

SANDY: There are two basic types of starch: *amylopectin* and *amylose*. Most of the starch found in starchy vegetables (potatoes, e.g.) is of the amylopectin type. Uncooked, the plant's cellulose cell walls make it very resistant to digestion in the small intestine. Once cooked, however, it becomes completely—and rapidly—digestible, causing a spike in blood glucose levels.

Amylose, the more slowly digested type of starch, is found in most starchy foods, but usually at low levels, so you don't get much of it in your diet. Because of selective plant breeding, however, high-amylose foods are now available. Our special resistant starch is at least 60% resistant owing to its amylose content. That means that only 40% of it is digestible—and very slowly at that.

Resistant Starch Improves Insulin Sensitivity

DURK: There's a lot of exciting research on resistant starch. For example, a 2005 study in the *American Journal of Clinical Nutrition* reports that researchers gave 30 g/day of resistant starch to 10 healthy human subjects over a 4-week period and found that their insulin sensitivity increased by 33% compared to placebo.[1] The glucose taken up by the forearm muscles rose, even with a lower insulin concentration; this demonstrated increased insulin sensitivity. Glucose passage into the forearm muscles was actually 44% higher than with placebo, representing an amazing increase in muscle receptivity to glucose.

SANDY: There are often differences in sensitivity to insulin in fat cells compared with muscle cells. But it's more desirable for glucose to be burned in muscles than converted to body fat. The big problem with ordinary starch is its rapid conversion to glucose, the consequence of which is that it feeds your fat tissues and gets stored as body fat. High levels of glucose in your bloodstream are dangerous and can cause deleterious side effects, both acute and chronic, so your body regulates glucose levels very tightly, with the excess being driven into fat cells.

DURK: Unfortunately, as you get older, your muscle cells become more resistant to the effects of insulin than your fat cells. Consequently, there's an increased partitioning of glucose into fat cells, where fatty acid synthase converts it into stored body fat. Less goes into the muscles, where it could be burned for energy. The loss of insulin sensitivity by muscles, as compared to fat tissue, is actually a solid marker of aging.

SANDY: In a 1999 paper in the *American Journal of Clinical Nutrition*, insulin sensitivity with resistant starch was improved rapidly.[2] I was surprised, because I thought that restoring insulin sensitivity caused by obesity and a bad diet might take a year or more. A few weeks of regular vigorous exercise or a substantial weight loss—neither of which is easy—can improve insulin sensitivity.

By using resistant starch in a cereal-based breakfast, however, researchers were actually able to achieve a substantial improvement in insulin resistance by the next meal, just a few hours later. There was also a higher satiety score for those eating the resistant starch: they felt full and satisfied longer than the people who didn't eat it.

Resistant Starch Lowers Blood Glucose and Triglycerides

DURK: What about people who have type 2 diabetes—a major killer—or borderline diabetes, as in metabolic syndrome? After all, resistant starch helps prevent insulin resistance, the basic problem with type 2 diabetes. In 1998, a paper in *Diabetes, Nutrition, & Metabolism* found that a meal containing resistant starch lowered blood glucose levels in type 2 diabetics by 32% and triglyceride levels by 26%.[3]

SANDY: The same year, a study in the *Journal of Nutrition* reported that rats with induced diabetes that were fed a high-glycemic-index diet ended up with increased levels of fatty acid synthase.[4] That's the final enzyme in the pathway that synthesizes fats from glucose—so they were making more fat. However, a low-glycemic-index diet with resistant starch reduced levels of fatty acid synthase, so they were making *less* fat, which is desirable for a diabetic. If you have high levels of fatty acid synthase, your body will make a lot of body fat, and you won't be able to lose weight.

DURK: Moreover, fatty acid synthase uses up your blood glucose, making you feel hungry due to low glucose. Three hours after eating a meal, your blood glucose can be lower than before eating, so you're hungry and you eat again. Your glucose and insulin increase, and your fatty acid synthase increases to get rid of the excess glucose. Then a few hours later, you're hungrier. You eat more, and more of that glucose ends up feeding your fat storage cells.

SANDY: It's a vicious cycle. By the way, fatty acid synthase expression was 68% higher in the rats on the high-glycemic-index diet compared to the low one—that's a huge difference!

A Little Resistant Starch Goes a Long Way

DURK: In a 2005 paper in *Bioscience, Biotechnology, and Biochemistry,* scientists examined the effects of 6 g of resistant starch on postprandial (after meal) blood glucose levels in normal humans and borderline diabetics.[5] It significantly inhibited both glucose and insulin levels.

Six grams is remarkably little resistant starch—only about 2 teaspoons. Yet blood glucose was reduced by about 10%, and the postprandial insulin level was reduced by 20% after 1 hour and by 29% after 1.5 hours. The total amount of insulin released was reduced by 44% in the borderline diabetic group and by 17% in all subjects. So for anyone who's starting to lose blood sugar control and develop insulin resistance, and essentially for anyone who is overweight, this is really important.

Resistant Starch Promotes Lipid Oxidation While Decreasing Body Fat

DURK: A 2004 paper published in *Nutrition and Metabolism* found that resistant starch consumption promoted lipid oxidation.[6] If you're fat, you want to burn up your fat—that's what lipid oxidation means. Ordinary starch promotes carbohydrate oxidation while increasing the synthesis of body fat from glucose, whereas resistant starch promotes lipid oxidation while decreasing body fat. That's remarkable!

To summarize, the researchers fed human subjects meals with resistant starch at levels of 0, 2.7, 5.4, and 10.7%. After the 5.4% meal, fat oxidation was 23% greater than after the regular meal, and this was optimal. For a meal containing 100 g (3 1/2 oz) of food, that's only 5.4 g of resistant starch, a mere 2 teaspoons. It's a very significant improvement from just a small change in your diet.

SANDY: A 2006 rat study in *Nutrition Journal* found that a diet high in resistant starch led to reduced fat-cell size compared to a diet high in digestible starch.[7] Both the rate of lipogenesis (the production of new fat) and fat-cell size were also lower following resistant-starch meals versus digestible-starch meals. And it works in humans just as it works in rats, the researchers note.

DURK: In 1996, *Lipids* published a paper on an animal diet containing either 8% guar gum or 20% resistant starch.[8] With a high-cholesterol diet, both the guar gum and the resistant starch were effective in lowering plasma cholesterol (about 40%) and triglycerides (about 36%).

While guar gum reduced cholesterol slightly more than resistant starch, it had a counteracting effect: it increased the expression of an enzyme called HMG-CoA reductase, which resistant starch did not do. HMG-CoA reductase is responsible for a crucial step in cholesterol biosynthesis; it's the enzyme that statins inhibit. So, unlike guar gum, resistant starch decreased cholesterol without increasing a cholesterol-synthesizing enzyme. If you want to keep your cholesterol levels down, more HMG-

CoA reductase is undesirable, although it's not necessarily true that the lower its activity, the better.

Resistant Starch Protects the Colon

SANDY: There are other interesting effects of resistant starch. In a 1998 paper from the *Journal of the American College of Nutrition*, resistant starch treatment resulted in a large increase (56%) of butyrate in the colon.[9] Butyrate is a short-chain fatty acid produced by fermentation by microbes in the large intestine. It's particularly protective against colon cancer, and it provides a fuel source for colon cells.

Butyrate also induces apoptosis (programmed suicide) of genetically damaged cells. Talk about a health food! Your colon is constantly being damaged by the products of food digestion, so it's good to shed and dispose of old cells that line the colon. Butyrate helps do just that.

DURK: In a 2006 article in *Diabetes Care*, scientists asked whether the effects of beta-glucan-rich barley and resistant starch on glycemic variables are additive.[10] We talked about this study in our last interview, but we didn't discuss resistant starch.

When the strain of barley we use in our glycemic control system was combined with resistant starch in breakfast muffins, the results were even better at lowering glycemic response than just barley or resistant starch alone. For barley alone, the total amount of glucose absorbed decreased by 17% compared with "placebo" muffins, and the total amount of insulin released decreased by 33%. For the resistant starch, these figures were 24% and 38%, respectively.

When barley and resistant starch were combined, however, the total amount of glucose absorbed decreased by almost twice as much—33%—and the total amount of insulin released was an amazing 59% lower.

SANDY: This is particularly important, because excess insulin is a risk factor, in and of itself, for atherosclerosis.

Erythritol: A Healthy Natural Sweetener

DURK: Now let's turn to our new sweetener, erythritol. Although there are a number of good artificial sweeteners, they lack the functional properties of sugars. You can bake a brownie with an artificial sweetener, but it won't be anything like a brownie. It will be noticeably "off," because sugar lends a lot to mouth feel, dissolvability, flavor release, and chewability—what bakers call fundamental functional properties.

SANDY: Artificial sweeteners don't taste like sugar, which is one reason people are looking for a natural sweetener. The sugar alcohols are very good in that respect.

They can be used in baked goods, candies, and other sweets, and their functional properties are similar to those of sugars.

Although there are many sugar alcohols—such as sorbitol, mannitol, and xylitol—an undesirable trait they have in common is that they tend to cause diarrhea. Owing to gut intolerance, there are laxative effects from consuming relatively modest amounts of most sugar alcohols. But your gut is very tolerant of erythritol.

DURK: Many studies were done on the metabolic and toxicological properties of erythritol in order for it to gain approval as a sweetener. It was found that erythritol does not have laxative effects at the levels that people typically use in food. In fact, people can drink 20 grams of erythritol dissolved in water twice a day without a laxative effect—far higher than any other sugar alcohol. Erythritol is absorbed rapidly, and almost all of it is excreted unchanged in the urine.

The FDA's official figures are grossly false and misleading with regard to erythritol. They say that it has 4 calories per gram, the same as any carbohydrate. It's true that if you burn erythritol in a calorimeter, you get the same amount of heat produced as with 4 grams of sugar, 4 grams of barley flour, or, for that matter, 4 grams of sawdust! But when your body burns erythritol, it's a whole different story. You can't burn sawdust in your body, and for the most part, the same is true with erythritol: at least 90% of it is excreted in your urine.

SANDY: A small amount, maybe 1%, is excreted in the feces, and a very small amount gets fermented by bacteria in the large intestine. Most of it is excreted unchanged, and it has virtually no glucose-increasing or insulin-increasing effect. Experiments with type 2 diabetics at 40 g/day of erythritol found no adverse effects or increases in blood levels of glucose or insulin.

DURK: Of the sugar alcohols, erythritol has the lowest caloric value: it's been measured at 0.4 calorie/g or less—that is, it has one-tenth the caloric value of sugar. And it has the same functional properties, so your cookie will crunch instead of mush, and it won't be hard as a brick. If you use erythritol instead of sugar, it will look like a cookie, taste like a cookie, crunch like a cookie, and dissolve in your mouth like a cookie.

Erythritol Does Not Have Sugar's Drawbacks

SANDY: In a 2002 study on diabetic rats published in the *Journal of Agricultural and Food Chemistry,* erythritol was found to reduce serum levels of 5-hydroxymethylfurfural, a sugar metabolite that undergoes harmful reactions with proteins and is an indicator of oxidative stress.[11] This is an example of a sugar metabolite that is much more dangerous than sugar itself. Chemically, such aldehyde metabolites act much like formaldehyde.

Also lowered by erythritol was a class of compounds called thiobarbituric acid-reactive substances (TBARS), which are products of the peroxidation of lipids by free radicals. Lipid peroxidation is central to the aging process. So by reducing the effects of glucose metabolism and lipid peroxidation, erythritol reduces typical diabetic damage. In the study, it was added to the diet rather than substituted for something else.

DURK: Erythritol is not only a good replacement for sugar, but it actually provides some important beneficial effects. Therefore, if you have a sweet tooth and love chocolate, cake, cookies, and other desserts, you ought to substitute erythritol for sugar, as we do. You won't know the difference from the way desserts taste or feel in your mouth, nor will you suffer the drawbacks of sugar. You can regain that unalloyed joy of eating dessert again!

Reversing the Downside of the Agricultural Revolution

SANDY: A revolution in food is occurring because of growing knowledge about how foods, such as starch, are metabolized and processed in the body. By understanding the metabolic pathways, it's possible to alter foods so that they produce healthful results, and give you food you like to eat, without the worries.

DURK: In a way, we're reversing the downside of the Agricultural Revolution, which made possible an immense increase in human population density, because with agriculture you could produce far more caloric value, with less effort, than you could by hunting and gathering. Before that, starvation was commonplace.

The Agricultural Revolution laid the groundwork, however, for the current food-processing industry, which has fostered a great increase in the amount of fat-rich foods, a great increase in our food's average glycemic index, and a great decrease in the amount of soluble and insoluble fiber in our foods. Although our average lifespan has increased dramatically, we now live long enough to suffer the liabilities of this type of diet. Sadly, it has brought about many of the things that lead to age-related diseases, such as cardiovascular disease, cancer, and diabetes.

Now we're starting to develop special agricultural products that return to what you would have gotten, long ago, through hunting and gathering: high levels of fiber rather than high levels of digestible starch.

It's All in the Recipes

LE: We want to encourage people to send in barley and resistant starch recipes, and we're announcing a recipe contest in this issue where people will be able to win free products (see ad at right).

SANDY: We'd sure like to see those recipes and try them ourselves!

DURK: Our special barley flour, quick flakes, whole flakes, and nuggets are high in beta-glucan and relatively high in resistant starch, but there are some use limitations. For example, if you want to make crunchy cookies and you use too much barley, you'll end up with chewy cookies. That's because beta-glucan is somewhat gummy. On the other hand, resistant starch promotes crispness and brittleness, which are fine for crunchy cookies.

SANDY: Your food not only tastes as good, but it actually keeps you feeling full longer. That's a tremendous effect. There's no willpower involved—when you feel full, you're full. And it's easy to use our special barley—you can add the flour to a drink that you have with your meal, or you can add it to a soup or sauce. You can add barley quick flakes to your breakfast cereal. The whole flakes can be used in place of rice in any dish where you use rice.

The resistant starch, however, needs to be put *into* something, such as brownies or cookies or cakes. It doesn't dissolve in water, so it must be added to various foods you cook. You can put it into casseroles and stews and all sorts of things where it's mixed in with other food and then cooked.

DURK: Essentially, resistant starch can replace anywhere from 50% to 100% of any starch you use in a recipe. You have to increase the amount of liquid you use in the recipe, though, because the resistant starch binds more water than ordinary starch.

There are many things that work over a short period of time, but if you continue taking them, they stop working. Are the wonderful effects of resistant starch sustainable, or is it a one-day wonder? The answer is: they are sustainable.

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A Glycemic Control Recipe

Using Barley Flour, Resistant Starch, and Erythritol

Blueberry Gingerbread Cake

3/8 cup	olive oil (or Durk & Sandy's High Oleic Sunflower Oil™)
1 1/2 cups	Glycemic Control Flour, plus a bit extra for dusting the baking pan
1 cup	Glycemic Control Erythritol
1/2 tsp	salt
3 tbsp	molasses
1	egg, large
1 tsp	ginger, freshly grated (or 1/2 tsp dried ground)
1 tsp	vanilla
1 cup	Glycemic Control Resistant Starch
1 tsp	cinnamon, ground
1/2 tsp	nutmeg, freshly grated (or store-bought ground)
1 1/2 tsp	baking soda
2 cups	fresh or canned (unsweetened, drained) blueberries
1 1/2 cups	buttermilk

Preparation is really quite simple. Once you have assembled the ingredients, it takes about 1 hour to make. Start by preheating your oven to 350ºF. Grease a 12 x 7-inch baking pan and dust with flour.

In the bowl of an electric mixer (ideally fitted with a whisk attachment), beat together the oil, erythritol, salt, and molasses until blended. Add the egg, ginger, and vanilla, and beat to blend. Set aside.

In a separate bowl, sift together the flour, resistant starch, cinnamon, nutmeg, and baking soda. In a small bowl, combine 3 tbsp of this mixture with the blueberries, and toss to coat.

Add one-third of the remaining flour mixture to the oil mixture, and mix to blend. Add 1/2 cup of the buttermilk and mix to blend. Repeat this procedure with the flour and the buttermilk two more times. The batter will be fairly thick and sticky. Fold the blueberries gently into the blended mix.

Pour the batter into the baking pan. Bake in the center of the oven for about 30 minutes, until the center is firm and a cake tester (or toothpick) inserted into the center comes out dry.

Transfer the pan to a wire rack to cool. Serve slightly warm. Makes about sixteen 1 3/4" x 3" pieces.

Durk Pearson & Sandy Shaw's 21st Century Weight Loss Program

Scientific Support for Glycemic Control
By Durk Pearson & Sandy Shaw

Our glycemic control strategy is the first part of our new approach to managing your weight. Simply by adding 2 tablespoons of our special beta-glucan-rich barley to your meals, you can reduce carbohydrate digestion and lower your glycemic response to those carbohydrates. Beta-glucan is a natural fiber found in large amounts in some grains, especially in barley and oats.

Our barley was developed by conventional selective breeding to contain about three times as much beta-glucan as in oats, and twice as much as in ordinary barley. In 100 g of our barley, there are 30 g of total dietary fiber, including 15 g of beta-glucan, as well as 18 g of high-quality, high-lysine protein; the fat content is 6.5 g.

The calorie content is, by FDA standards, 3.9 calories/g. However, this is true only if you measure calories by burning foodstuffs in a calorimeter, which is not how it works in your body. The actual calorie content of our glycemic-control barley flour (also available as quick flakes and nuggets) is about 2.7 calories/g. The FDA's definition of calories is grossly false and misleading, since it attributes the same number of calories/g to all carbohydrates, including indigestible fiber. If you can't use it to generate energy for your body's use, it shouldn't be considered to have caloric content.

The carbohydrate content in 100 g of our barley flour or quick flakes is 64.3 g (but 30 g of that is dietary fiber, so there is actually only 34.3 g of potentially digestible carbohydrates per 100 g of this barley).

Our barley has one of the lowest glycemic indexes for commonly consumed foods: just 25 for a serving as a hot cereal—almost as low as lentils (22) and remarkably low for a grain-based food. Whole wheat bread, for example, has a glycemic index of about 60, while oats as a hot cereal is about 58. Numerous studies report beneficial effects of a diet high in beta-glucan from barley.

Feeling Full and Satisfied After a Meal

The longer elevation of the satiety hormone cholecystokinin after consumption of barley-containing meals means feeling full and satisfied longer. Cholecystokinin, released by the small intestine following a meal, is one of the major signals telling you that you are full. In one study, 11 healthy men were fed either barley pasta high in beta-glucan or a low-beta-glucan wheat pasta. Although their cholecystokinin levels returned to baseline concentrations 3 hours after the low-fiber pasta meal, cholecystokinin levels remained above baseline concentrations for 6 hours following consumption of barley pasta high in beta-glucan.[1]

Another study[2] reported that, in a sample of 39 overweight or obese young adults 18–40 years old who were on an energy-restricted diet that was either low-glycemic or low-fat, the resting energy expenditure (which typically decreases when energy is restricted) decreased less with the low-glycemic-load diet than with the low-fat diet. *Participants receiving the low-glycemic-load diet reported less hunger than those receiving the low-fat diet.* CRP and blood pressure were also reported to improve more with the low-glycemic-load diet. (CRP is C-reactive protein, a marker of inflammation; high CRP levels correlate with high risk for cardiovascular disease.)

A review of a number of studies on high-glycemic-index foods, hunger, and obesity[3] revealed, not surprisingly, that not all studies produced the same results. The contents of human diets are very complex (hence studies of their effects on glycemic index are usually just estimates), with subject populations varying greatly. The review noted that the majority of short-term studies showed either a significant or a nonsignificant reduction in subsequent hunger and/or increased satiety following consumption of low-GI foods, compared with consumption of high-GI foods. However, the author notes that there were differences between the test diets in variables such as energy density or palatability that may have contributed to the results.

The author also says, “Hunger, as assessed by subsequent energy intake, however, was consistently higher in five of five studies (significantly so in three studies), suggesting that *when direct measurements are made of the parameter of interest (i.e., energy intake), consumption of high-GI foods does tend to promote subsequent overeating relative to consumption of low-GI foods.*” [Emphasis added] Also, as summarized in his Table 5, “… most but not all studies attempting to separate the effects of glucose and insulin as satiety signals have suggested that glucose level, rather than associated insulin level, is a primary signal of satiety.” Thus, the effect of our special barley’s dietary fiber in producing a “slow release” of glucose from carbohydrate may play a role in its effects on extended feelings of fullness and satisfaction.

Reduced or Slower Absorption of Carbohydrate

Carbohydrate was more slowly absorbed from the two high-fiber barley meals.[1] Both barley meals also resulted in a significantly lower cholesterol increase at 30 minutes after the meal than did the low-fiber meal. Although the plasma glucose response was not blunted by the high-fiber meals in this study, the plasma insulin response did differ, indicating that the meal with beta-glucan-enriched pasta was associated with increased insulin sensitivity.

In another study, carbohydrate digestion in humans from a beta-glucan-enriched barley was reported to be reduced.[4] The particular type of naturally beta-glucan-rich barley we use, Prowashonupana (which contains about 15% beta-glucan soluble fiber plus about the same percentage of insoluble fiber) was particularly effective in reducing carbohydrate digestion. As the authors report, "When cereals such as Prowashonupana are consumed with a meal, once the bolus reaches the small intestine the viscosity of the meal is increased. This high viscosity delays absorption. *A 50% reduction in the glycemic peak has been achieved with a concentration of 10% beta-glucan in a cereal."* [Emphasis added]

Reduced Glucose and Insulin Peaks Following Meals

Another paper[5] reported that barley beta-glucan-enriched durum wheat pasta resulted in a *lower glycemic response and a lower insulin* response in five fasted adult subjects who were fed test meals of a barley and durum wheat blend pasta containing 100 g of available carbohydrate, with 30 g of total dietary fiber, including 12 g of beta-glucan. The authors of this paper suggest that "Barley beta-glucan may be an economical and palatable ingredient for processed food products formulated to modify glycemic and insulin response."

Another study compared the effects of a barley (Prowashonupana) cereal vs. oatmeal on the blood glucose and insulin response in normal and diabetic subjects.[6] The paper reports that *in normal (nondiabetic) subjects, the maximal rise in glucose from baseline was 41.3 ± 3.9 mg/dL after oatmeal and 6.4 ± 2.7 mg/dL after barley (Prowashonupana),* while the maximal increase in glucose was 26.3 ± 3.9 mg/dL after the commercial liquid meal replacer (LMR) used as a reference standard. The maximal increase in glucose in the diabetic subjects was 80.8 ± 8.8 mg/dL after oatmeal, 28.4 ± 3.5 mg/dL after barley (Prowashonupana), and 69.9 ± 4.5 mg/dL after LMR. *The maximal increase in insulin after oatmeal was 29.9 ± 4.2 mIU/ml in the nondiabetic subjects and 21.4 ± 2.5 mIU/ml in the diabetic patients, while the maximal insulin increase after barley (Prowashonupana) was 8.6 ± 1.5 mIU/ml in the nondiabetic controls and 6.8 ± 1.2 mIU/ml in the diabetic patients.*

In another study,[7] ten overweight women (age 50 years) consumed 1 g of glucose per kg of body weight and four test meals containing 1 g of carbohydrate per kg of body weight, with two-thirds of the carbohydrate from oat flour, oatmeal, barley flour, or barley flakes and the other one-third from pudding. The barley used was Prowashonupana. Results showed that *peak glucose and insulin levels after barley were significantly lower than those after glucose or oats.* Areas under the curve (AUC, a measure of the total amount of a given substance in the bloodstream over time) after test meals showed that glucose AUCs were reduced by both oats (29–36% lower) and barley (59–65%). The insulin AUCs after test meals compared with glucose AUCs were significantly reduced only by barley (44–56%).

Reduced Total Cholesterol and LDL-Cholesterol

In a study of 11 healthy men,[1] the two barley-containing meals significantly reduced cholesterol after 30 minutes as compared with a low-fiber meal. *Consumption of the barley-containing meals appeared to stimulate reverse cholesterol transport, the process by which cholesterol is eliminated from cells, and that may have contributed to the cholesterol-lowering effect of the barley.*

We have emphasized human studies here, but there have been far more animal studies on the effects of beta-glucan. One study reported that beta-glucan fractions from barley and oats are similarly antiatherogenic in hypercholesterolemic hamsters.[8] Aortic cholesterol ester concentrations were reported to be significantly reduced in hamsters consuming 8 g/100 g of beta-glucan from barley or oats. The study showed that the cholesterol-lowering potency of beta-glucan "is approximately identical whether its origin was oats or barley." However, our special barley flour, quick flakes, and nuggets contain three times as much beta-glucan per unit volume compared with oat fiber.

Some, but not all, studies of oat beta-glucan have shown positive effects (i.e., a reduction) on LDL-cholesterol. As we explained above (in the section on "Feeling Full and Satisfied After a Meal"), discrepancies are to be expected because of the complexity of human diets and the tremendous diversity among individuals in how they deal with carbohydrates and other dietary constituents. McIntosh et al.[9] reported that plasma LDL-cholesterol concentrations were lowered by 7% in mildly hypercholesterolemic men who consumed about 170 g of barley containing 8 g/day of beta-glucan for 4 weeks. (Note that 170 g of our barley flour or quick flakes contains 25.5 g of beta-glucan, not 8 g.) The barley was incorporated into pasta.

In another study[1] (see more on this study above, under "Feeling Full and Satisfied"), Bourdon et al. reported that postprandial plasma cholesterol concentrations were lowered at 30 minutes and at 4 hours after beta-glucan-containing meals in a study of men who were fed either of two high-beta-glucan (from barley) pastas that provided 5 g of beta-glucan per meal.

Another study[10] reported that, in mildly hypercholesterolemic women (9) and men (7), the addition of 3 g (medium) or 6 g (high) beta-glucan/day from barley to an American Heart Association Step I (reduced-fat) diet reduced cholesterol significantly compared with the Step I diet or the diet with low beta-glucan.

Improvement in Gut Bacterial Populations Increased Formation of Short-Chain Fatty Acids

One study in which dietary fiber-rich barley products were fed to rats[11] showed that the numbers of potentially pathogenic coliform and *Bacteroides* bacteria in the small intestine, cecum, and colon were reduced, whereas the numbers of beneficial

Lactobacillus bacteria were higher, as compared with placebo-fed rats. Similarly, short-chain fatty acids were higher in the colon and feces of the groups receiving the high-fiber barley supplements, and the concentrations of excreted bile acids increased by up to 30% during the feeding period. The increased excretion of bile acids as a result of the increased viscosity of the beta- glucan helps to decrease cholesterol, since more cholesterol must be used to replace the cholesterol excreted in the bile acids. The short-chain fatty acids occur as a result of bacterial fermentation of the indigestible beta-glucan (as well as the resistant starch included with the barley in this study).

The increased production of short-chain fatty acids has protective effects against the development of colon cancer and has also been reported to inhibit cholesterol synthesis by the liver.[12]

Reduction of C-Reactive Protein

C-reactive protein (CRP) is a nonspecific marker of inflammation that has been shown in a number of studies to be a strong predictor of risk for cardiovascular disease. A large epidemiological study[13] of 3920 men and women aged 20 years or more (data from the National Health and Nutrition Examination Survey 1999–2000) reported that *dietary fiber intake was inversely associated with serum C-reactive protein concentration.* (The higher the dietary fiber intake, the lower the CRP.) The odds ratio for increased CRP concentration (>3.0 mg/L) was 0.49 for the highest quintile of fiber intake compared with the lowest. After adjusting for age, gender, race, education, smoking, physical activity, body mass index (BMI), total energy intake, and fat intake, the odds ratio was 0.59. This means that there was a 41% decrease in likelihood of having an increased CRP concentration in those consuming fiber intake in the highest quintile compared with the lowest. The researchers did not have information on the type of dietary fiber, such as soluble (which is harder to get in the diet) vs. insoluble. The fiber intake was estimated from dietary interviews for foods and beverages consumed during the previous 24-hour period.

Another study[14] reported that, in a study of 244 apparently healthy middle-aged women, there was a strong and statistically significant positive association between dietary glycemic load and plasma high-sensitivity CRP. CRP levels were measured, whereas average dietary glycemic load was determined with a validated semiquantitative food-frequency questionnaire. Adjustments were made for age, treatment status, smoking status, BMI, physical activity, parental history of heart attack, history of hypertension, diabetes, or high cholesterol, postmenopausal hormone use, alcohol intake, and other dietary variables.

Increased HDL-Cholesterol

In a cross-sectional study of 1420 middle-aged adults[15] (from the 1986/87 Survey of British Adults), the glycemic index of the diet was the only dietary variable significantly related to serum HDL-cholesterol concentration. The authors concluded, "… our findings are compatible with the hypothesis that a diet with low glycemic index increases HDL-cholesterol concentration by improving insulin sensitivity …" The results showed an even stronger effect on HDL for women than for men.

Immune System Stimulation

Beta-glucans from a variety of sources, including barley, fungi, yeast, and seaweed, have been shown to stimulate the immune system by their effects on granulocytes (neutrophils and eosinophils), monocytes, macrophages, and natural killer cells.[16] One paper[16] reports that orally administered beta-glucans from barley and yeast were "taken up by macrophages that transported them to spleen, lymph nodes, and bone marrow. Within the bone marrow, the macrophages degraded the large beta-1,3-glucan into smaller, soluble beta-1,3-glucan fragments that were taken up by the CR3 [a receptor for complement, part of the innate immune system] of marginated granulocytes." Granulocytes with CR3-bound beta-1,3-glucan fragments were shown to kill tumor cells coated with iC3b [an inactivated complement receptor] in a mouse tumor model where mice were treated with antitumor monoclonal bodies and beta-glucan. In this model, tumor regression required the presence of iC3b on tumors and CR3 on granulocytes.[11]

A particularly interesting study[17] *reported that 5-day-old piglets pretreated with beta-glucan from yeast orally (50 mg/day per pig) and then exposed to the infamous swine flu (capable of infecting humans) did much better than piglets exposed to the flu without pretreatment with beta-glucan.* The untreated piglets had significantly more severe microscopic lung lesions induced by the swine flu than did the beta-glucan-treated piglets. There were significantly higher concentrations of interferon-gamma and nitric oxide in bronchoalveolar lavage fluid from piglets pretreated with beta-glucan and infected with swine flu, indicating a stronger antiviral immune response in the beta-glucan-pretreated piglets.

Other studies have shown *protective effects of beta-glucan against a variety of infections in mice*, including *Staphylococcus aureus* septicemia, Venezuelan equine encephalomyelitis virus, and Rift Valley fever virus.[18-20] Beta-glucan was administered in these studies intravenously, intranasally, or intraperitoneally, presumably because it is easier to control the administered dose by these routes than by oral treatment. Effects depended upon the route of administration. For example, in Reference 18, treatment of mice before challenge with virulent *Francisella tularensis* provided increased resistance when beta-glucan was given intravenously, but not when it was given intranasally. On the other hand, intranasal beta-glucan pretreatment increased the survival of mice when challenged by aerosol with *Pseudomonas pseudomallei*, whereas intravenous beta-glucan pretreatment did not increase survival.

Clearly, more research needs to be done on the potential immune-stimulating effects of beta-glucan, but this natural product cannot be patented, so no pharmaceutical industry research funds can be expected to be invested in this effort. Nor can it be expected that the NIH will be interested (they have a lot on their plate, and there is no political constituency pushing the agency for beta-glucan research). The work will be done by the dietary supplement and food industries, but only if the truthful and nonmisleading information resulting from this research can be communicated to the public. A lot depends upon the FDA, and the communication of truthful information is not one of their priorities.

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