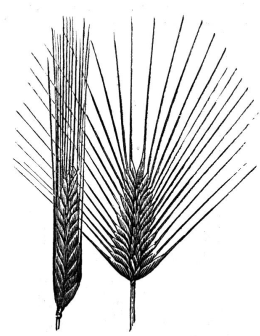
Making Whole Grains Even Healthier



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Whole Grains: Breaking Barriers Conference

November 9-11, 2014, Boston, MA

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Making Whole Grains Even Healthier

All across the spectrum, category by category, whole grain foods are healthier than the same foods made without whole grains. While that's the basic starting point, we're now learning there are ways we can make whole grain foods *even healthier*. In this section, we'll look at three key concepts:

Sprouted Grains

Grains are storage containers for a potential new plant. When this new plant begins to sprout, changes take place in the grain that enhance its nutrients and make them more bio-available.

- What is a sprouted grain?
- Why are sprouted grains healthier?
- How can sprouted grains be incorporated into products?
- Two bread recipes from Master Baker Peter Reinhart

Sourdough Fermentation

Bakers everywhere welcomed the availability of commercial baking yeast for its consistent, uniform behavior. Recent science, however, finds some surprising advantages to the old ways of sourdough fermentation.

- The old ways of bread baking
- Sourdough lowers glycemic impact
- Specific sourdough fermentation techniques render wheat technically gluten-free

Glycemic Impact

Human bodies depend on a steady supply of glucose (blood sugar) as their principal fuel. Good health – and everyday energy – depend on choosing foods that don't send our blood sugar on a roller coaster ride.

- Explanation of glycemic index, glycemic load and glycemic response
- The GI of various grains
- Pasta's Documented Difference
- Scientific Consensus Statement on Glycemic Index, Glycemic Load, and Glycemic Response

What is a sprouted grain?

Grains are the seeds of certain plants, largely cereal grasses. Like all seeds, grain kernels are a marvel of nature, containing the potential of a whole new plant, patiently waiting its turn in the sun until temperature and moisture conditions are just right.

Once sprouting starts, enzyme activity transforms the long-term-storage starch of the endosperm to simpler molecules that are easily digested by the growing plant embryo. A sprouted grain has begun to grow into a new plant – but just barely. This is the point at which the growth of sprouted grains is normally stopped: when the new sprout is shorter than the length of the original grain. At this point, it's still considered a grain; as it grows further, it becomes a cereal grass stalk– something humans can't easily digest.

There is at this time no regulated definition of "sprouted grain." Consumers who want to understand what they are eating, and companies who are considering manufacturing or marketing sprouted grains may find it useful to start by reviewing how AACCI, formerly known as the American Association of Cereal Chemists and one of the world's leading authorities on grains, defines sprouted grains; their definition has subsequently been endorsed by USDA.

In early 2008, AACCI's Board of Directors decreed that, "Malted or sprouted grains containing all of the original bran, germ, and endosperm shall be considered whole grains as long as sprout growth does not exceed kernel length and nutrient values have not diminished. These grains should be labeled as malted or sprouted whole grain."

> Source: "Whole Grains," AACC International, http://www.aaccnet.org/initiatives/definitions/pages/wholegrain.aspx.

All Sprouted Grains are Whole Grains

Sprouted grains are always whole grains. All components of the grain (bran, germ, and endosperm) are required for the growth of the sprout. In fact, the sprout comes from the germ, so if the germ has been removed (such as in refined wheat), it won't "germinate" – another word for sprouting.

Sprouting Whole Grains Makes Them Even Healthier!

Just as the baby plant finds these enzyme-activated simple molecules easier to digest, so too may some people. Proponents of sprouted grains claim that grains that have just begun sprouting – those that are straddling the line between a seed and a new plant, as discussed here — offer all the goodness of whole grains, while being more readily digested.

What's more, the sprouting process apparently increases the amount and bio-availability of some vitamins and minerals, making sprouted grains a potential nutrition powerhouse. For example, in a 2013 study in *Food Chemistry*, scientists comparing antioxidant activity in white rice, brown rice and sprouted brown rice, found sprouted brown rice had the highest antioxidant levels. Similarly, Indian scientists sprouted millet and found that iron was 300% more bioaccessible, manganese 17% and calcium was "marginally" more bioaccessible. Sprouting can also increase nutrients. Egyptian researchers found that sprouting wheat increased folate levels 3- to 4-fold, and Vietnamese researchers found that sprouted wheat was higher in dietary fiber, free amino acids and phenolic compounds than unsprouted wheat.

Sprouting is also associated with positive health outcomes. Korean researchers sprouted brown rice to increase its gamma-aminobutyric acid (GABA). Higher GABA levels then slowed the growth of leukemia cells. In another study, Japanese researchers found that people eating sprouted brown rice had better blood sugar and lipid control than those eating white rice. Similarly, Canadian researchers fed white bread, whole grain bread, sourdough bread and sprouted grain bread to overweight males and found that the sprouted grain bread invoked the mildest glycemic response.

With all of this information, it is important to keep in mind that consumption of whole grains (sprouted or not) is associated with high diet quality and nutrient intake. A large study found that those eating the most whole grains had significantly higher amounts of fiber, energy and polyunsaturated fats, as well as all micronutrients (except vitamin B-12 and sodium). Additionally, a high consumption of whole grains (sprouted or not) is associated with a decreased risk of stroke, type 2 diabetes, heart disease, asthma, inflammation, and many other conditions.

Sources:
Norhaizan Mohd. Esa et al., “Antioxidant activity of white rice, brown rice, and germinated brown rice (*in vivo* and *in vitro*) and the effects on lipid peroxidation and liver enzymes in hyperlipidaemic rabbits,” *Food Chemistry* 141, no. 2 (November 2013): 1306-1312, doi: 10.1016/j.foodchem.2013.03.086.

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Anita Mofidi et al., “The Acute Impact of Ingestion of Sourdough and Whole-Grain Breads on Blood Glucose, Insulin, and Incretins in Overweight and Obese Men,” *Journal of Nutrition and Metabolism* 58, no. 13 (June 2010): 8100-8103, doi: 10.1021/jf100846e.

Carol E. O’Neil et al., “Whole-grain consumption is associated with diet quality and nutrient intake in adults: the National Health and Nutrition Examination Survey, 1999-2004,” Journal of the American Dietetic Association 110, no. 10 (October 2010):1461-1468, doi: 10.1016/j.jada.2010.07.012.

Sprouted Grains and Shelf Life

When a grain sprouts, the unstable unsaturated fats in the germ are assimilated into the new plant, making them more stable. This could explain why sprouted grain flour (a dry product) has been reported to have a longer shelf life than regular whole grain flour. Some breads and other products are made with "wet mash" sprouts – sprouted grains that have not been dried and turned into flour. These products generally have a shorter shelf life than other whole grain breads because of their high moisture levels; you will most often find these in the freezer at supermarkets.

Substituting Sprouted Grains in Baking

Sprouted grain flour can be directly substituted for non-sprouted flour in most recipes. According to To Your Health Sprouted Flour Co., "Sprouted flour tends to have a higher absorption rate than regular conventional flour. If your recipe calls for very little or no fat (butter, oil, buttermilk, etc.), or if you are working with yeast, we recommend you add one tablespoon of liquid per cup of sprouted flour (called for in your recipe)."

In commercial baking applications, sprouted wheat has several advantages over unsprouted wheat, according to Kevin Richter of Ardent Mills. Working with its own sprouted flour, his company has found that sprouted flour offers:

- 50%+ increase in dough stability
- 10% decrease in proofing time
- 8-12% increase in dough volume

Ardent finds that the natural increase in dough volume means that vital wheat gluten can be reduced or even eliminated; they also find that added sugars can be reduced by 50% because the sprouted grain is naturally sweeter.

Sources:
"Questions and Answers," To Your Health Sprouted Flour Co., http://www.organicsproutedflour.net/qa.html.

Keith Richter, Engineering Analyst at Ardent Mills. Presentation at AACC International Annual Meeting, Providence, RI, October 6, 2014.

Want to try baking sprouted grain breads yourself?
Try the two recipes from master baker Peter Reinhart, found on the following pages.

Sprouted Whole Wheat Bread • Master Formula
Peter Reinhart

(Makes one large loaf, or two smaller loaves and up to 15 rolls)

This master dough can be used to make any number of shapes and sizes. It showcases the natural sweetness and tenderness of sprouted wheat flour without the addition of oil, fat, or other enrichments such as milk, eggs, and sweeteners. Sprouting the wheat changes it enough so that many of the rules for artisan breads, such as the use of preferments and long, slow rising times, can be accomplished by the flour itself in less time because the enzyme activity provided by long fermentation and preferments is already accomplished during the sprouting phase.

Note: you will need a few teaspoons of vegetable or olive oil for this to make an oil slick on your work surface for the stretch and folds required.

measure	ounces	grams	ingredient	%
4 1/2 cups	16 oz	454g	sprouted wheat flour	100
1 teaspoon	0.25 oz	7g	kosher salt	1.5
1 1/2 tsp.	0.16 oz	4.5g	instant yeast	1
1 cup plus 6 1/2 oz.	14.5 oz	411g	water (approx. 70℉)	90
	30.91 oz	876.5g		Total192.5

If using an electric mixer, use the paddle attachment not the hook, mixing on slow speed. Or, in a mixing bowl, use a large spoon. Stir together the flour, salt, and yeast in the mixing bowl and then add the water. Mix or stir for approximately 1 minute or until all the flour is absorbed and forms a coarse, wet dough. Do not add more flour, as the dough will thicken while it sits.

Let the dough rest, uncovered, for 5 minutes, Then, if using an electric mixer, increase to medium slow speed (or continue mixing with the spoon) and mix for one additional minute. The dough should become smooth but but will still be very soft and sticky.

Using 1 teaspoon of vegetable or olive oil, make an oil slick on the work surface. Use a wet or oiled plastic bowl scraper, or a rubber spatula, and transfer dough to the oil slick. Rub a small amount of oil on your hands and stretch and fold the dough. The dough will firm up slightly but still be very soft and somewhat sticky. Cover the dough with the mixing bowl and then, at 5 minute intervals, perform three additional stretch and folds (s&f).

Note: these intervals can be extended to up to twenty minutes each; with each s&f, lightly oil your hands to prevent sticking. The dough should firm up a little more with each s&f. By the final fold, it will become soft and supple, tacky, and have a springy or "bouncy" quality when patted. After the fourth and final s&f place the dough in an oiled bowl or container, cover with plastic wrap or a lid (do not lay the plastic wrap on the dough, but stretch it tightly over the bowl or container), and ferment the dough at room temperature for approximately 90 minutes (this time can be shortened if using a warm proof box set anywhere up to 90°F / 32°C). The dough should double in size. *(cont. on next page)*

SPROUTED WHOLE WHEAT BREAD (CONTINUED)

Make another oil slick on the work surface and use an oiled bowl scraper or rubber spatula to transfer the dough to the slick. Shape the dough for either hearth baking or for a sandwich loaf, or divide and shape it for smaller loaves or rolls. Place the shaped dough in an oiled loaf pan, a floured proofing basket (such as a *banneton*), on a *couche,* or on a parchment lined sheet pan (or use a silicon baking pad). Mist the top of the dough with spray oil and cover it loosely with plastic wrap. Proof for 60 to 90 minutes at room temperature, or until the dough grows by 1 1/2 times in size. (Note: because the dough is so fully hydrated it is fragile and will fall if you proof to double in size. It is better to bake it while it is still on the rise and, when poked with your finger, it should spring back within a few seconds rather than hold the dimple.)

Preheat the oven and prepare it for hearth baking and steaming. If using a baking stone, the stone will require at least 45 minutes of preheating.

If hearth baking, transfer the dough to a lightly floured peel (if baking directly on the sheet pan you do not need to transfer it). Score the dough as desired. Transfer the dough onto the baking stone and add 1 cup of water to the steam pan. For hearth bread, bake at 450°F/232°C with steam, for approximately 30 to 35 minutes. If using a loaf pan, bake at 375°F/191°C for approximately 45-55 minutes, steam is optional. If using a convection oven, reduce temperatures by 25°F/14°C In most ovens, it will probably be necessary to rotate the loaves after about 15 minutes for even baking. When the internal temperature of the bread reaches 190°F/88°C for soft loaves, or 200°F/93°C for crusty hearth bread remove it from the oven and transfer to a cooling rack for at least 30 minutes before serving.

Notes:

- For a crisper crust, turn off the oven when the bread appears to be done but leave the bread in for an additional 5 minutes to drive off more moisture. You can also return the cooled bread to a hot oven, 450°F/232°C, for 5 minutes to re-crisp the crust prior to serving.
- If using the overnight method, transfer the covered bowl of dough to the refrigerator immediately after the final stretch and fold. The next day, remove it from the refrigerator 3 1/2 hours before you plan to bake. Shape the cold dough and proof it at room temperature, proceeding as described.

Gluten-Free Sprouted Corn Bread
Peter Reinhart

(Makes 1 pan, 8 servings)

measure	ounces	grams	ingredient
3 1/4 cups	14 oz	397g	Sprouted corn meal flour or sprouted corn grits
(up to 2 oz/57 g in substitution for an equal amount of the sprouted corn flour)			Optional: Teff flour or sprouted quinoa flour or your favorite ancient grain or bean flour, sprouted or non sprouted, up to 2 oz substitution for sprouted corn.
1/2 cup sugar or 4 1/2 tablespoons honey or agave, or 1/2 teaspoon liquid stevia	3 oz	85g	sugar (or honey or agave or liquid stevia)
1 1/2 tablespoons	0.75 oz	21.5g	baking powder
1/2 teaspoon	0.125 oz	3.5g	baking soda
1 teaspoon	0.25 oz	7g	salt
2 1/2 cups	20 oz	567g	buttermilk
2 eggs	3.5 oz	99g	eggs
2 tablespoons	1 oz	57g	unsalted butter (melted)
2 tablespoons	1 oz	57g	bacon fat (or melted butter) for pan
To taste			Optional ingredients: See recipe (corn kernels, diced vegetables, bacon bits)

Preheat the oven to 350℉ (177℃).

In a mixing bowl, stir together the dry ingredients: sprouted corn meal, sugar (if using), baking powder, baking soda, and salt. In a separate bowl, whisk together the buttermilk, eggs, and 2 tablespoons of melted butter (if using honey, agave, or liquid stevia add it into the wet ingredients). Add the liquid ingredients to the dry ingredients and stir with a large spoon or whisk for about 1 minute to make a smooth, pourable batter. Add optional ingredients such as corn kernels or diced vegetables and stir to evenly distribute.

(cont. on next page)

Gluten-Free Sprouted Corn Bread (continued)

Grease a 9-inch round cake pan or an 8-inch square baking pan (you can use a larger pan for a thinner cornbread) with either 2 tablespoons of bacon fat or 2 tablespoons of melted butter. Place the pan in the oven for about 2 minutes, or until the fat almost starts to smoke or the butter starts to brown (browned butter is good, but not blackened butter). Remove the pan from the oven and pour the batter into it to fill evenly (sprinkle the optional bacon pieces over the top, if using), and place the pan on the middle shelf of the oven.

Bake for 25 minutes, then rotate the pan and continue baking for another 25 minutes, or until the corn bread is firm and springy when poked in the center (a toothpick should come out clean if inserted into the center). Bake longer if needed (if using corn kernels it will probably take an additional 5 minutes or longer). Cool the cornbread in the pan for 20 minutes before cutting and serving.

Sourdough Fermentation

For thousands of years, getting dough to rise was more art than science. Bakers would mix flour and water then leave it to ferment in the open air, where it would pick up wild yeasts and other microbes in the air. Or they would add bits of fermented dough (starter) from the last batch of bread to the newest batch.

The process was slow and unpredictable, but had two main advantages: fermentation developed extra layers of flavor in the bread, and gave it a longer shelf life. Both of these traits were especially important when bread was the mainstay of many diets and baking was a time-consuming process done weekly or even less frequently in most homes.

In the late 1800s, yeast was isolated as a separate organism and made available to both commercial bakers and home bread-makers. Suddenly making bread became more predictable, and much quicker – a boon to commercial bakers looking to maximize factory output.

But the change helps explain why many of today's breads contain long lists of ingredients. There are barley malts and sugars to feed the yeast, and dough conditioners and preservatives added to help the dough develop and to give the bread longer shelf-life.

Questions arise: What can we learn from the "old ways" of making bread, that could be adapted to our modern food system? Are there any other important attributes of sourdough fermentation that could benefit our health? The answers may surprise you.

Sourdough Lowers Glycemic Impact
Sourdough breads tend to have a lower glycemic impact than yeast breads. The mechanism may be related to higher fiber content (sourdough apparently encourages the development of resistant starch) and lower pH.

Put that piece of the puzzle together with other information at this conference, and you may conclude that the healthiest loaf of bread is a sprouted whole grain sourdough loaf!

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Sourdough Fermentation Helps Break Down Gluten
Recent research from Italy adds a new twist to the benefits of sourdough. Scientists at the University of Bari, led by Marco Gobbetti, published a study in 2007 demonstrating that slow sourdough fermentation of wheat with certain strains of lactobacilli and fungi can lower gluten levels in ordinary wheat from their normal 75,000 ppm (parts per million) to as little as 12 ppm – a level considered legally and technically gluten free In most countries.

In a nutshell, while some humans have trouble digesting the complex gluten proteins, they may not have trouble if some helpful "good" bacteria have pre-digested the gluten before the wheat is made into baked goods.

The Whole Grains Council contacted Dr. Gobbetti and asked him whether he had done further research to follow up on his team's original findings. The answer was a resounding yes, as we wrote in a blog (August 6, 2014):

Whole Grains Council: We were fascinated by your earlier study. Have you continued to learn more on this topic?

Dr. Gobbeti: Yes, many further developments were achieved. After the discovery that a mixture of fungal proteases and selected sourdough lactobacilli degraded gluten to below 20 ppm during sourdough fermentation, we further explained the enzyme mechanism for gluten degradation, including the epitopes responsible for celiac disease.

Whole Grains Council: Sounds like you've made good progress in the lab, on the theory behind what you refer to as "digested flour." But what about in real life?

Dr. Gobbetti: Based on these encouraging foundations, and in cooperation with physicians, we carried out an in vivo [human/real life] challenge with celiac patients. The patients ate about 200 grams of sweet baked goods daily, made with our [specially fermented] wheat flour. The wheat flour in these baked goods originally contained the equivalent of around 10 grams of gluten, that had been completely digested [by the fermentation process].The trial lasted 60 days, and based on serological, hematological and intestinal permeability analyses, all the patients completely tolerated the sweet baked goods.

After this challenge, a second 60-day in vivo challenge was carried out under almost the same conditions with other celiac patients, only this time intestinal biopsies were also carried out. Again, in this case, we observed 100% tolerance of our baked goods made with digested wheat flour.

Whole Grains Council: Wow. 100% tolerance, in celiac patients, documented by intestinal biopsies. What comes next?

Dr. Gobbetti: Nowadays, a third and final in vivo challenge is running. Celiac patients will ingest baked goods made with digested wheat flour each day for 6 months. The study will conclude at the end of this year but some patients have already finished the challenge – once again showing complete tolerance.

Whole Grains Council: Could you please clarify – did you do your studies using whole wheat flour or using refined flour? We're guessing you could potentially turn either one into "digested" flour?

Dr. Gobbetti: We got our results both on whole wheat flour and on refined flour; the results are the same with both.

Whole Grains Council: Is anyone using this "digested flour" in commercial baking yet? Either in Italy or here in the US?

Dr. Gobbetti: The approach is not currently available on the market. We are co-inventors of the process with an Italian company (Giuliani SpA), which has patented this nationally and internationally. This company also funded the last part of the in vivo research and developed an industrial plant for the manufacture of leavened baked goods to be made with the sourdough fermented wheat flour. The company hopes to be ready for the market in mid-2015. Obviously, the U.S. market will also be interested!

Whole Grains Council: The work that you and your group are doing is fascinating. Now that you have done two in vivo trials and are partway through a third, longer trial, it seems you are very clearly establishing the safety of this digested wheat for celiacs. Do you mind if we share your emails in a blog?

Dr. Gobbetti: It's a pleasure to share our results with you. Please feel free to use them!

Sources:
Carlo G. Rizzello et al., "Highly Efficient Gluten Degradation by Lactobacilli and Fungal Proteases during Food Processing: New Perspectives for Celiac Disease," *Applied and Environmental Microbiology* 73, no. 14 (2007):4499-4507, accessed October 30, 2014 http://www.ncbi.nlm.nih.gov/pubmed/17513580.

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Glycemic Index, Glycemic Load, and Glycemic Response

Human bodies depend on a steady supply of glucose (blood sugar) as their principal fuel, in order for muscles to stretch and contract, nerves to fire, brains to function – and so much more. Glucose comes from carbohydrates, so the quality and quantity of carbohydrates we eat hugely impacts our energy levels and overall health.

Too little glucose, and we starve many bodily functions (especially the brain, which uses 11-20% of the glucose we produce). Too much, and our body scrambles to produce enough insulin to process all that blood sugar – and we may develop heart disease, eye, kidney and nerve damage. Ideally, our food delivers a steady stream of just the right amount of glucose.

But how do we distinguish foods, meals and diets that raise our blood sugar too high and too fast from those that dole out their fuel slowly and steadily to support good health? Understanding glycemic index, glycemic load and glycemic response can help.

Glycemic Index (GI), developed by David Jenkins, Thomas Wolever and colleagues at the University of Toronto in 1981, ranks the *quality* of individual carbohydrate-rich foods on a scale of 1-100 by measuring how glucose levels rise after someone eats an amount of that food containing 50 grams of carbohydrate. Foods with a low GI score (under 55) provide steady fuel to support energy levels and overall health, while those with a high GI score (70 and up) are likely to provide an unhealthy quick rush of blood sugar followed by a sharp crash.

Walter Willett and colleagues at the Harvard School of Public Health created the concept of Glycemic Load. **Glycemic Load** (GL) combines *quality* and *quantity*, allowing us to rank how the typical serving size of a food affects blood sugar. A GL of 0-10 is considered low (slow, steady conversion to blood sugar; healthier), while a high GL is 20 and up (flash and crash – tough on health and energy levels). Research shows why GI and GL *both* matter: a low glycemic load can be achieved either by eating small amounts of high GI carbs, or large amounts of low-GI carbs, and some studies show that the latter approach (i.e. low-GI, low-GL) is best of all for health.

While both GI and GL are useful measures of our glycemic response to certain foods or dishes, our body's overall **Glycemic Response** – *our management of blood sugar over time* – also appears to depend on our *total diet and lifestyle*.

As useful as GI, GL, and GR can be, it's important to keep in mind that understanding the effect of carbohydrates on blood sugar is just one part of choosing a healthy diet. The quality of fats and proteins matters too, as do fiber, vitamins, minerals and other factors. The bottom line? Eating a wide variety of delicious, whole, minimally-processed foods, guided by the latest science in all these areas, is the way to go.

Tips for Better Blood Sugar Control

The refreshing news is that reaping the benefits of a low-glycemic diet doesn't mean only looking at numbers. The principle of glycemic health is important, and traditional eating patterns such as the Mediterranean Diet offer a good example of how to enjoy delicious food while safe-guarding your good health.

Here are a dozen ideas anyone can use to easily bring the science of glycemic index, glycemic load and glycemic response to their everyday meals and snacks.

- In general, whole and minimally-processed foods are better choices than highly-processed foods, for keeping blood sugar steady.
- Choose traditional muesli, or hot oatmeal or porridge (not instant) instead of processed flakes or puffs.
- Favor whole fruits over fruit juice, and enjoy juice in small quantities or mixed with sparkling water.
- Skip the fluffy, light breads. Traditional dense grainy bread has a much lower glycemic index.
- Pasta has a low glycemic index, especially when it's cooked *al dente*. Enjoy pasta with plenty of vegetables and beans or fish for a healthy pasta meal.
- Enjoy balanced meals and snacks. Eating healthy fats and lean protein with carbohydrates lowers the overall glycemic load of a meal or snack.
- Eat legumes. Serve lentil soup, a bean-filled chili, or a chickpea salad. Add beans to soups, salads, pasta and other dishes – or try mashing white beans with your potatoes.
- Certain fibers, including resistant starch (found in foods including beans, bananas, cold pasta and potato salads), lower your body's glycemic response. A mostly-plant-based diet provides a good variety of different types of fiber.
- Eat a variety of intact whole grains, and be sure not to overcook them. Intact grains such as barley, wheatberries and ryeberries have a low glycemic index, especially when they're cooked *al dente*.
- Add zest. Acidic foods lower your glycemic response, so squeeze lemon juice on your broccoli, eat your breakfast cereal with yogurt, and add a salad with vinaigrette dressing to your dinner.
- Enjoy snacks like carrots with hummus, apple slices with nut butter, or plain yogurt with fresh or frozen berries.
- Practice portion control. Too much of even a healthy food is, well, too much. Serve yourself a modest portion, eat slowly and mindfully, and reflect before you reach for more.

The Glycemic Index of Various Grains

Some recent best-selling diet books state that all grains cause dangerous spikes in blood sugar – spikes that can lead to diabetes, inflammation and a host of other ills.

In fact, many grains and grain foods have a low glycemic index – including pasta. And a large body of research ties whole grain consumption to *reduced* risk of diabetes and inflammation.

It's true that blood sugar levels matter. Research links many chronic diseases, from diabetes to heart disease, with eating too many foods that send your blood sugar on a roller coaster ride (see Scientific Consensus Statement at the end of this section). Indeed, when you eat such foods, especially those made with highly processed grains and sugar, your blood sugar can spike then quickly plummet, leaving your energy depleted and causing damage to essential bodily systems. It's healthier to choose foods that provide a steady, slow release of glucose (blood sugar).

The Glycemic Index rates how quickly carbohydrate foods are converted into glucose – and you may be surprised to learn that many grain foods have a low GI score (considered 55 or less on the 1 to 100 GI scale).

Virtually all intact whole grains have a very low GI score. Check out these typical scores from the Harvard School of Public Health and the University of Sydney :

Grain food	GI score
whole grain barley	27
rye berries	29
whole wheat kernels	30
whole wheat pasta	42
buckwheat	45
"white" pasta	46
brown rice	48
bulgur	48
corn tortilla	52
quinoa	53
oatmeal	55

Sourdough and Sprouting
Sourdough breads generally have a lower GI than yeast breads; sprouted flour also generally has a lower glycemic impact than unsprouted flour. As we learn more and more about the factors that enhance the innate goodness of whole grains, there are many ways for manufacturers to incorporate this new knowledge into healthy new products.

> Source: Anita Mofidi et al., "The Acute Impact of Ingestion of Sourdough and Whole-Grain Breads on Blood Glucose, Insulin, and Incretins in Overweight and Obese Men," *Journal of Nutrition and Metabolism* (2012) doi: 10.1155/2012/184710.

Remember, GI isn't the only measure of food quality!
While Glycemic Index is one important gauge of food quality, it must be considered in the context of other factors. Ice cream and some candy bars have a lower GI than most fruits and intact grains, because of their high levels of unhealthy fats; choosing foods only by their GI could result in a very unbalanced diet!

It's also important to remember that the deep body of research supporting the benefits of whole grains is based on whole grain foods with a wide range of glycemic index ratings – including breads, crackers, pasta, hot and cold breakfast cereals, and grain side dishes.

Make sure to include plenty of intact whole grains in your diet, from side dishes, salads and stir-fries, to breakfast porridges. Then use your common sense in choosing other whole grain foods. We all know that a whole grain cookie is still a cookie!

Pasta's Documented Difference

When it comes to Glycemic Index (GI) the structure of a food matters too. If we mix durum wheat with water and extrude it through dies we get spaghetti, with a GI of 42-45; if we take the same ingredients and bake them into a nicely-leavened dough, we get bread with a GI of 70-80 or even higher.

Cooking matters too. When pasta is cooked al dente, its GI is lower than if the pasta is overcooked. Cool that al dente pasta and enjoy It in a pasta salad, and its GI plummets still further, as the formation of resistant starch slows digestion even more. Top pasta with olive oil and lots of vegetables, and the Glycemic Load (GL) of the meal makes it even healthier. That's pasta's documented difference.

Repeated Studies Show Lower Glycemic Impact of Pasta
Thirty years ago, when the concept of Glycemic Index was new, scientists quickly noted that pasta was somehow different, with lower impact on blood sugar. Here's what one early study found:

> The blood glucose response to feeding 50-g carbohydrate portions of white and wholemeal bread and white spaghetti was studied in a group of nine diabetic subjects. Blood glucose rises after white and wholemeal bread were identical, but the response after spaghetti was markedly reduced. These results emphasize that food form rather than fiber may be important in determining the glycemic response and that pasta may be a useful source of carbohydrate in the diabetic diet.
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> *Jenkins DJ, Wolever TM, Jenkins AL, et al. Glycemic response to wheat products: reduced response to pasta but no effect of fiber. Diabetes Care, 1983 Mar-Apr;6(2):155-9*

Additional research over the next three decades backed up these initial findings:

> Research shows that couscous has a higher glycemic effect than pasta although it has a similar composition. In the first small experiment, 8 healthy people were assigned to 50g of carbohydrates of either pasta or couscous. Those that ate the pasta had significantly lower blood sugar after eating than the couscous group, as well as significantly lower area under the curve (a measure of glucose tolerance). Next, researchers gave 6 patients with diabetes a meal of either pasta with tomato sauce, or couscous with vegetables and sauce (meals had a similar distribution of carbohydrates, protein, and fat). Again, the pasta group had significantly lower blood glucose after eating than the couscous group.
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> *Jamel et al., Comparative effects of couscous and pasta on glycemia in normal subjects and type 1 diabetics. Diabète et Metabolisme. 1990 Jan-Feb;16(1):37-41*

> Glycemic response is consistently lower after eating a pasta meal than three other popular takeaway meals. In an Australian study, people with type I diabetes were given either pasta carbonara, Thai cashew chicken with rice, a cheeseburger and fries, or a ham and cheese sandwich with an apple. The pasta meal produced a glycemic response that was significantly lower than that of all the other meals by all measurements (area under curve, 2h BGL, and BGL range), despite the fact that all meals had the same amount of carbohydrates.
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> *MacDonald et al., Effect of popular takeaway foods on blood glucose levels.... International Journal of Clinical Practice. 2009 Feb;63(2):189-94.*

> We know that eating pasta has a lower glucose and insulin response compared to other foods, but research shows that this effect also lasts into the next meal as well. In a Swedish study, researchers measured blood glucose levels in healthy volunteers after giving them a variety of different meals. The scientists found that after eating the spaghetti at one meal (compared to whole wheat bread), the volunteers had significantly lower glucose and insulin responses after their next meal, in a phenomenon dubbed 'the second meal effect'.
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> *Liljeberg H, Björk I, et al., Effect of the glycemic index and content of indigestible carbohydrates of cereal-based breakfast meals on glucose tolerance at lunch in healthy subjects. American Journal of Clinical Nutrition. 1999;69:647-55*

What's the Mechanism?

The structure of starch molecules in pasta seems to be responsible for its slow ("lente") digestion. As seen above in Jamel's study, even couscous – also made from compacted durum semolina, but not extruded – has a higher Glycemic Index. The compact starch molecules in pasta resist digestive enzymes long enough so that it releases its energy steadily and slowly.

> The three pasta products [(1) macaroni 25% durum/75% wheat (2) spaghetti 100% durum wheat (3) 'spaghetti porridge' – cooked spaghetti mixed in a food processor] produced significantly lower peak blood glucose values and lower GI (90 min) than the corresponding bread… The 'lente' properties of the pasta were assigned to a restricted enzymic availability due to a more compact food texture.
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> *Granfeldt Y, Björck I. Glycemic response to starch in pasta: a study of mechanisms of limited enzyme availability. Journal of Cereal Science. 1991;14(1):47-61.*

Pasta Shape Matters Too

Once you know that it's the compact starch molecules of pasta that resist rapid digestion, it's only logical that different shapes and sizes of pasta would also have slightly different Glycemic Index ratings.

> Thicker, larger pasta shapes tend to have a lower glycemic index than thinner, smaller ones. For example, spaghetti has a glycemic index of 45, while macaroni has a glycemic index of 68. Similarly, thick linguini has a lower glycemic index than thin linguine.
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> *Pi-Sunyer FX. Glycemic index and disease. American Journal of Clinical Nutrition. 2002 Jul;76(1):2905-2985.*

The bottom line? If you're looking for high-quality carbohydrates, don't overlook pasta – especially whole grain pasta. Whole grain pasta has the same GI advantages, with the added bonus of extra nutrients and fiber. Enjoyed in moderate amounts (not huge mounds!) with delicious vegetable sauces, beans, or flavor accents of meat or fish, pasta is a healthy carbohydrate choice.

Scientific Consensus Statement on Glycemic Index, Glycemic Load and Glycemic Response

An international panel of experts has formed the "Carbohydrate Quality Consortium (CQC)" which met in Stresa, Italy on June 6-7, 2013. At this Summit, co-organized by Oldways and the Nutrition Foundation of Italy, the group discussed the importance of carbohydrate quality and quantity. Their deliberations resulted in the following twenty point Scientific Consensus Statement:

1. Carbohydrates present in different foods have distinct physiological effects, including effects on post-prandial glycemia (PPG), also known as the glycemic response[1], with different implications for health.

2. Reducing PPG is recognized as a beneficial physiological effect *(Ceriello and Colagiuri 2008, Levitan et al. 2004, Coutinho et al. 1999)*

3. Ways to reduce PPG include slowing carbohydrate absorption by consuming low glycemic index (GI)[2] and low glycemic load (GL)[3] foods to reduce the dietary GI and GL *(Jenkins et al. 2001, Salmeron et al. 1997).*

4. The GI methodology is a sufficiently valid and reproducible method for differentiating foods based on their glycemic response *(Wolever, 2013, Brouns et al. 2005).*

5. The GI quantifies specific physiological properties of carbohydrate-containing foods as influenced by the food matrix. These characteristics extend beyond their chemical composition including delaying gastric emptying and reducing the rate of digestion and small intestinal absorption.

6. When considering the macronutrient composition, the GL/1000kJ (the product of GI and available[4] carbohydrate content) is the single best predictor of the glycemic response of foods *(Bao et al. 2011).*

7. There is convincing evidence from meta-analyses of controlled dietary trials that diets low in GI improve glycemic control in people with type 2 diabetes *(Brand-Miller et al 2003, Livesey et al 2008, Thomas and Elliot 2010, Jenkins et al. 2012).*

8. There is convincing evidence from meta-analyses of prospective cohort studies that low GI/GL diets reduce the risk of type 2 diabetes *(Barclay et al 2008, Livesey et al 2013).*

9. There is convincing evidence from a large body of prospective cohort studies that low GI/GL diets reduce the risk of coronary heart disease *(Liu et al. 2000, Mirrahimi et al 2012, Fan et al. 2012).*

10. The proof of principle for the concept of slowing carbohydrate absorption is the use of alpha-glucosidase inhibitors (acarbose etc.) to reduce progression to type 2 diabetes and coronary heart disease *(Chiasson et al. 2002, Chiasson et al. 2003).*

11. The quality of carbohydrate foods as defined by GI/GL is particularly important for individuals who are sedentary, overweight and at increased risk of type 2 diabetes *(Salmeron et al. 1997, Ludwig et al. 2002).*

12. Potential mechanisms for reduction of type 2 diabetes include evidence that low GI/GL diets improve insulin sensitivity and beta-cell function in people with type 2 diabetes and those at risk for type 2 diabetes *(Rizkalla et al. 2004, Solomon et al. 2011).*

13. Potential mechanisms for reduction of coronary heart disease include evidence that low GI/GL diets improve blood lipids and inflammatory markers including C-reactive protein (CRP) *(Frost et al. 1999, Liu et al. 2001, Liu et al. 2002, Wolever et al. 2008, Shikany et al. 2010, Goff et al. 2013).*

14. Probable evidence exists for low GI/GL diets in body weight management *(Larsen et al. 2010, Murakami et al. 2013, Bouche' et al. 2002, McMillan-Price et al. 2006, Ebbeling et al. 2007).*

15. The GI complements other ways of characterizing carbohydrate-foods, such as fiber and whole grain content *(Riccardi et al. 2008, Slavin 2008).*

16. Low GI and low GL should be considered in the context of a healthy diet.

17. Given the rapid rise in diabetes and obesity there is a need to communicate information on GI/GL to the general public and health professionals.

18. This should be supported by inclusion of GI/GL in dietary guidelines and in food composition tables.

19. In addition package labels and low GI/GL symbols on healthy foods should be considered.

20. More comprehensive high-quality food composition tables need to be developed for GI/GL at the national level.

Footnotes / Definitions:
1. Glycemic response: is the simple term for the post-prandial blood glucose concentration (PPG) elicited by a food or a meal.

2. Glycemic Index (GI): Conceptually, GI is the glycemic response elicited by a portion of a carbohydrate-rich food containing 50g (or in some cases 25g) available carbohydrate expressed as a percentage of that elicited by 50g (or 25g) glucose. GI is precisely defined by the ISO (International Organization for Standardization) method 26642:2010 (http://www.iso.org/iso/home/store/catalogue_tc/catalogue_detail.htm?csnumber=43633)

3. Glycemic load (GL): is the product of GI and the total available carbohydrate content in a given amount of food (GL = GI x available carbohydrate/given amount of food). Available carbohydrates can have different modes of expression: g per serving, g per 100g food, g per day intake, and g per 1000 kJ or 1000 calories, dependent on the context in which GL is used. Thus GL has corresponding units of g per serving, g per 100 g food, and g per 1000 kJ or 1000 calories.

4. Available carbohydrate: Is the carbohydrate in foods that is digested, absorbed and metabolised as carbohydrate. Available carbohydrate is sometimes referred to as glycemic carbohydrate.

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Scientific Consensus Committee for the Stresa Conference:

Chairs:

David J.A. Jenkins, MD, PhD, DSc, University Professor and Canada Research Chair in Nutrition and Metabolism, Department of Nutritional Sciences, Faculty of Medicine, University of Toronto, Director, Risk Factor Modification Centre, St. Michael's Hospital (Toronto, Canada)

Walter C. Willett, MD, DrPH, Fredrick John Stare Professor of Epidemiology and Nutrition Chair, Department of Nutrition, Harvard School of Public Health (Boston, USA)

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Livia Augustin, PhD, Research Fellow, Risk Factor Modification Centre, St. Michael's Hospital (Toronto, Canada)

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Alan W. Barclay, PhD, Head of Research, Australian Diabetes Council; Chief Scientific Officer Glycemic Index Foundation (Sydney, Australia),

Inger Björck, PhD, Professor and Managing Director Antidiabetic Food Centre, Lund University (Lund, Sweden)

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Anette E. Buyken, PhD, Research Associate, Department of Nutritional Epidemiology, University of Bonn (Bonn, Germany).

Antonio Ceriello, MD, Head of Research at the Institut d'Investigacions Biomèdiques August Pi i Sunyer (IDIBAPS) (Barcelona, Spain)

Cyril W.C. Kendall, PhD, Research Associate, Department of Nutritional Sciences, Faculty of Medicine, University of Toronto (Toronto, Canada) and Adj. Professor College of Pharmacy and Nutrition, University of Saskatchewan (Saskatoon, Canada)

Carlo La Vecchia, MD, Chief, Department of Epidemiology, Mario Negri Institute, and Professor of Epidemiology, University of Milan, (Milan, Italy)

Geoffrey Livesey, PhD, Director, Independent Nutrition Logic (Wymondham, UK)

Simin Liu, MD, ScD, Professor, Dept. of Epidemiology and Medicine, Brown University (Providence, USA)

Andrea Poli, MD, Scientific Director, Nutrition Foundation of Italy (Milan, Italy)

Gabriele Riccardi, MD, Full Professor of Endocrinology and Metabolic Diseases, Dept. of Clinical Medicine and Surgery, Federico II University (Naples, Italy)

Salwa W. Rizkalla, MD, PhD, DSc, Senior Researcher, National Institute of Health and Medical Research (INSERM) U 872, team 7, Research centre in human nutrition, ICAN Institute of Cardiometabolism & Nutrition, University Pierre et Marie Curie-Paris 6, Centre of Research in Human Nutrition, Pitié Salpêtrière Hospital (Paris, France).

John L. Sievenpiper, MD, PhD, Toronto 3D Knowledge Synthesis and Clinical Trials Unit, Clinical Nutrition and Risk Factor Modification Centre, St. Michael's Hospital (Toronto, Canada), Department of Pathology and Molecular Medicine, Faculty of Health Sciences, McMaster University (Hamilton, Canada).

Antonia Trichopoulou, MD, PhD, Professor and Director, World Health Organization Collaborating Centre for Food & Nutrition, Department of Hygiene and Epidemiology, University of Athens Medical School, and Vice President, Hellenic Health Foundation (Athens, Greece)

Thomas M.S. Wolever MD, PhD, Professor, Department of Nutritional Sciences, University of Toronto (Toronto, Canada)