The Traditional Preparation of Grains

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ONE

Improperly Prepared Grain Fiber can be Harmful

Last year, I published a post on the Diet and Reinfarction trial (DART), a controlled trial that increased grain fiber intake using whole wheat bread and wheat bran supplements, and reported long-term health outcomes in people who had previously suffered a heart attack (1). The initial paper found a trend toward increased heart attacks and deaths in the grain fiber-supplemented group at two years, which was not statistically significant.

What I didn't know at the time is that a follow-up study has been published. After mathematically "adjusting" for preexisting conditions and medication use, the result reached statistical significance: people who increased their grain fiber intake had more heart attacks than people who didn't during the two years of the controlled trial. Overall mortality was higher as well, but that didn't reach statistical significance. You have to get past the abstract of the paper to realize this, but fortunately it's free access (2).

Here's a description of what *not* to eat if you're a Westerner with established heart disease:

> Those randomised to fibre advice were encouraged to eat at least six slices of wholemeal bread per day, or an equivalent amount of cereal fibre from a mixture of wholemeal bread, high-fibre breakfast cereals and wheat bran.

Characteristics of Grain Fiber

The term 'fiber' can refer to many different things. Dietary fiber is simply defined as an edible substance that doesn't get digested by the human body. It doesn't even necessarily come from plants. If you eat a shrimp with the shell on, and the shell comes out the other end (which it will), it was fiber.

Grain fiber is a particular class of dietary fiber that has specific characteristics. It's mostly cellulose (like wood; although some grains are rich in soluble fiber as well), and it contains a

number of defensive substances and storage molecules that make it more difficult to eat. These may include phytic acid, protease inhibitors, amylase inhibitors, lectins, tannins, saponins, and goitrogens (3). Grain fiber is also a rich source of vitamins and minerals, although the minerals are mostly inaccessible due to grains' high phytic acid content (4, 5, 6).

Every plant food (and some animal foods) has its chemical defense strategy, and grains are no different*. It's just that grains are particularly good at it, and also happen to be one of our staple foods in the modern world. If you don't think grains are naturally inedible for humans, try eating a heaping bowl full of dry, raw whole wheat berries.

Human Ingenuity to the Rescue

Humans are clever creatures, and we've found ways to use grains as a food source, despite not being naturally adapted to eating them**. The most important is our ability to cook. Cooking deactivates many of the harmful substances found in grains and other plant foods. However, some are not deactivated by cooking. These require other strategies to remove or deactivate.

Healthy grain-based cultures don't prepare their grains haphazardly. Throughout the world, using a number of different grains, many have arrived at similar strategies for making grains edible and nutritious. The most common approach involves most or all of these steps:

- Soaking
- Grinding
- Removing 50-75% of the bran
- Sour fermentation
- Cooking

But wait, didn't all healthy traditional cultures eat whole grains? The idea might make us feel warm and fuzzy inside, but it doesn't quite hit the mark. A recent conversation with Ramiel Nagel, author of the book *Cure Tooth Decay*, disabused me of that notion. He pointed out that in my favorite resource on grain preparation in traditional societies, the Food and Agriculture Organization publication *Fermented Cereals: a Global Perspective*, many of the recipes call for removing a portion of the bran (7). Some of these recipes probably haven't changed in thousands of years. It's my impression that some traditional cultures eat whole grains, while

others eat them partially de-branned.

In the next post, I'll explain why these processing steps greatly improve the nutritional value of grains, and I'll describe recipes from around the world to illustrate the point.

* Including tubers. For example, sweet potatoes contain goitrogens, oxalic acid, and protease inhibitors. Potatoes contain toxic glycoalkaloids. Taro contains oxalic acid and protease inhibitors. Cassava contains highly toxic cyanogens. Some of these substances are deactivated by cooking, others are not. Each food has an associated preparation method that minimizes its toxic qualities. Potatoes are peeled, removing the majority of the glycoalkaloids. Cassava is grated and dried or fermented to inactivate cyanogens. Some cultures ferment taro.

** As opposed to mice, for example, which can survive on raw whole grains.

TWO

Soaking or Germinating Grains

The most basic method of preparing grains is prolonged soaking in water, followed by cooking. This combination reduces the level of water-soluble and heat-sensitive toxins and anti-nutrients such as tannins, saponins, digestive enzyme inhibitors and lectins, as well as flatulence factors. It also partially degrades phytic acid, which is a potent inhibitor of mineral absorption, an inhibitor of the digestive enzyme trypsin and an enemy of dental health (1). This improves the digestibility and nutritional value of grains as well as legumes.

I prefer to soak all grains and legumes for at least 12 hours in a warm location, preferably 24. This includes foods that most people don't soak, such as lentils. Soaking does not reduce phytic acid at all in grains that have been heat-treated, such as oats and kasha (technically not a grain), because they no longer contain the phytic acid-degrading enzyme **phytase**. Cooking without soaking first also does not have much effect on phytic acid.

The next level of grain preparation is germination. After soaking, rinse the grains twice per

day for an additional day or two. This activates the grains' sprouting program and further increases their digestibility and vitamin content. When combined with cooking, it reduces phytic acid, although modestly. Therefore, most of the minerals in sprouted whole grains will continue to be inaccessible. Many raw sprouted grains and legumes are edible, but I wouldn't use them as a staple food because they retain most of their phytic acid as well as some heat-sensitive anti-nutrients (2).

Grinding and Fermenting Grains

Many cultures around the world have independently discovered fermentation as a way to greatly improve the digestibility and nutritive value of grains (3). Typically, grains are soaked, ground, and allowed to sour ferment for times ranging from 12 hours to several days. In some cases, a portion of the bran is removed before or after grinding.

In addition to the reduction in toxins and anti-nutrients afforded by soaking and cooking, grinding and fermentation goes much further. Grinding greatly increases the surface area of the grains and breaks up their cellular structure, releasing enzymes which are important for the transformation to come. Under the right conditions, which are easy to achieve, lactic acid bacteria rapidly acidify the batter. These bacteria are naturally present on grains, but adding a starter makes the process more efficient and reliable.

Due to some quirk of nature, grain phytase is maximally active at a pH of between 4.5 and 5.5, which is mildly acidic. This is why the Weston Price foundation recommends soaking grains in an acidic medium before cooking. The combination of grinding and sour fermentation causes grains to efficiently degrade their own phytic acid (as long as they haven't been heat treated first), making minerals much more available for absorption (4, 5, 6, 7). This transforms whole grains from a poor source of minerals into a good source.

The degree of phytic acid degradation depends on the starting amount of phytase in the grain. Corn, rice, oats and millet don't contain much phytase activity, so they require either a longer fermentation time, or the addition of high-phytase grains to the batter (8). Whole raw buckwheat, wheat, and particularly rye contain a large amount of phytase (9), although I feel wheat is problematic for other reasons.

As fermentation proceeds, bacteria secrete enzymes that begin digesting the protein, starch and other substances in the batter. Fermentation reduces lectin levels substantially, which are reduced further by cooking (10). Lectins are toxins that can interfere with digestion and may be involved in autoimmune disease, an idea championed by Dr. Loren Cordain. Grain lectins are generally heat-sensitive, but one notable exception is the nasty lectin wheat germ agglutinin (WGA). As its name suggests, WGA is found in wheat germ, and thus is mostly absent in white flour. WGA may have been another reason why DART participants who increased their wheat fiber intake had significantly more heart attacks than those who didn't. I don't know if fermentation degrades WGA.

One of the problems with grains is their poor protein quality. Besides containing a fairly low concentration of protein to begin with, they also don't contain a good balance of essential amino acids. This prevents their efficient use by the body, unless a separate source of certain amino acids is eaten along with them. The main limiting amino acid in grains is lysine. Legumes are rich in lysine, which is why cultures around the world pair them with grains. Bacterial fermentation produces lysine, often increasing its concentration by many fold and making grains nearly a "complete protein", i.e. one that contains the ideal balance of essential amino acids as do animal proteins (11, scroll down to see graph). Not very many plant foods can make that claim. Fermentation also increases the concentration of the amino acid methionine and certain vitamins.

Another problem with grain protein is it's poorly digested relative to animal protein. This means that a portion of it escapes digestion, leading to a lower nutritive value and a higher risk of allergy due to undigested protein hanging around in the digestive tract. Fermentation followed by cooking increases the digestibility of grain protein, bringing it nearly to the same level as meat (12, 13, 14, 15). This may relate to the destruction of protease inhibitors (trypsin inhibitors, phytic acid) and the partial pre-digestion of grain proteins by bacteria.

Once you delve into the research on traditional grain preparation methods, you begin to see why grain-eating cultures throughout the world have favored certain techniques. Proper grain processing transforms them from toxic to nutritious, from health-degrading to health-giving. Modern industrial grain processing has largely eschewed these time-honored techniques,

replacing them with low-extraction milling, extrusion and quick-rise yeast strains.

Many people will not be willing to go through the trouble of grinding and fermentation to prepare grains. I can sympathize, although if you have the right tools, once you establish a routine it really isn't that much work. It just requires a bit of organization. In fact, it can even be downright convenient. I often keep a bowl of fermented dosa or buckwheat batter in the fridge, ready to make a tasty "pancake" at a moment's notice. In the next post, I'll describe a few recipes from different parts of the world.

THREE

In my last two posts on grains, I described how traditional food processing methods make grains more nutritious and digestible. I promised to briefly describe a few recipes from around the world, then got distracted by other things. Here they are.

Africa: Ogi

Grain fermentation is widespread in Africa and is probably nearly as old as agriculture on the continent. The nutritional importance of fermentation is suggested by the amount of time and effort that many African cultures put into it, when they could save themselves a lot of trouble by simply soaking and cooking their grains.

Ogi is a common West African porridge that's eaten as a staple food by people of all ages. It's even used as a weaning food. It's made in essentially the same manner from corn, sorghum or millet.

Whole grain is soaked in water for one to three days. It's then wet milled, mixed with water and sieved to remove a portion of the bran. Extra bran is fed to animals, while the white, starchy sediment is fermented for two to three days. This is then cooked into a thin or thick porridge and eaten.

South America: Pozol

At first glance, some people may think I left the 'e' off the word 'pozole', a traditional Mexican stew. However, pozol is an entirely different beast, an ancient food almost totally unknown in the US, but which fueled the Mayan empire and remains a staple food in Southeastern Mexico.

To make pozol, first the corn must be 'nixtamalized': whole kernels are boiled in a large volume of water with calcium hydroxide (10% w/v). This is a processing step in most traditional South American corn recipes, as it allows a person to avoid pellagra (niacin deficiency)! The loosened bran is removed from the kernels by hand.

The kernels are then ground into dough, formed into balls and placed into banana leaves to ferment for one to 14 days. Following fermentation, pozol is diluted in water and consumed raw.

Europe: Sourdough Bread

Sourdough bread is Europe's quintessential fermented grain food. Before purified yeast strains came into widespread use in the 20th century, all bread would have been some form of sourdough.

Although in my opinion wheat is problematic for many people, sourdough fermentation renders it more nutritious and better tolerated by those with gluten/wheat sensitivity. In an interesting series of studies, Dr. Marco Gobbetti's group, among others, has shown that fermentation partially degrades gluten, explaining the ability of fermentation to decrease the adverse effects of gluten in those who are sensitive to it (3). They even showed that people with celiac disease can safely eat wheat bread that has been long-fermented with selected bacteria and yeasts under laboratory conditions (4). Rye contains about half the gluten of bread wheat, and is generally nutritionally superior to wheat, so sourdough rye is a better choice in my opinion.

To make sourdough bread, first the dry grains are ground into flour. Next, the flour is sifted through a screen to remove a portion of the bran. The earliest bread eaters probably didn't do this, although there is evidence of the wealthy eating sifted flour in societies as old as ancient

Egypt and ancient Rome. I don't know what the optimum amount of bran to include in flour is, but it's not zero. I would be inclined to keep at least half of it, recognizing that the bran is disproportionately rich in nutrients.

Next, a portion of flour is mixed with water and a "sourdough starter", until it has a runny consistency. The starter is a diverse culture of bacteria and yeast that is carefully maintained by the bread maker. This culture acidifies the batter and produces carbon dioxide gas. The mixture is allowed to ferment for 8-12 hours. Finally, flour and salt are added to the batter and formed into dough balls. These are allowed to ferment and rise for a few hours, then baked.

My Experience

I've tried making ogi (millet) and pozol, and I have to admit that neither attempt was successful. Pozol in particular may depend on local populations of bacteria and yeast, as the grains' microorganisms are killed during processing. However, I do eat fermented grains regularly in the form of homemade brown rice 'uthappam' and sourdough buckwheat 'crepes'. The buckwheat crepes are tasty and easy to make. I'll post a recipe at some point.

The first two recipes are from the FAO publication *Fermented Cereals: a Global Perspective* (5).