

# Understanding Whole Grains & Whole Grain Flour

*By*

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*December 2023*

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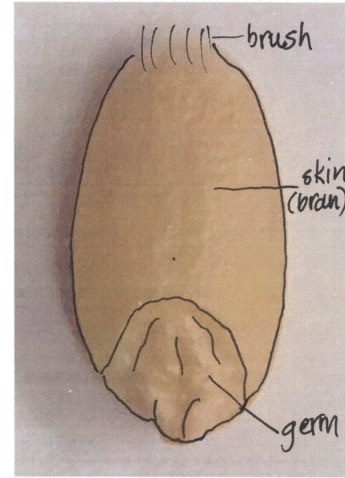
# Some background & history

- *The way in which we process grains and make bread in the Western World, changed drastically 150 years ago, and I have been here on earth for half that time. Time enough to witness the effects of that drastic change.*
- *Born in England, Swedish mother always had whole grain rye crispbread in the house.*
- *1940s Wartime bread and rationing of sugar and fat in UK , we now know that this protected against heart disease*
- *1950s Hovis bread or bleached white bread*
- *1960s Granary bread or bleached white bread*
- *1970s Many people in UK with heart disease or colon cancer*
- *1976 In California, Met husband Gene Spiller and then Denis Burkitt and Hugh Trowel, physicians who had worked in Africa for 20 years – no heart disease or colon cancer among Africans living in the countryside on local whole foods*
- *1980s Began whole grain work – nutrition, whole wheat sourdough*
- *1990s Landrace wheat studies at local educational farms & with California farmers*
- *2000 Founded Whole Grain Connection to promote whole grain foods and sell California appropriate landrace wheat seed*

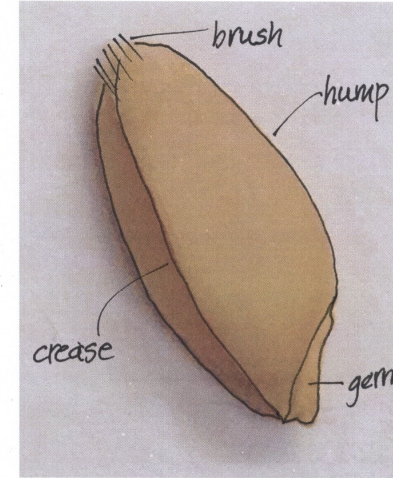
# What are whole grains?

- *Whole grain wheat is the same as wheat seed. If it is a genuine unbroken wheat seed, you can sprout it.*
- *The end of the seed that produces the sprout is the germ.*
- *The thin colored seed skin is the bran, which is edible, tasty, and a necessary part of food; it is dietary fiber that carries other foods all the way through the digestive system, without being itself digested.*
- *The middle endosperm of the wheat seed or grain, is filled with starch and protein, which is the store of food for the new wheat sprout.*
- *The growing plant can only use this stored starch and protein if the vitamins and minerals are being provided by the germ and the bran.*
- *Similarly, people need to eat the vitamins and minerals in the germ and bran to properly use the starch for energy and the protein for growth.*

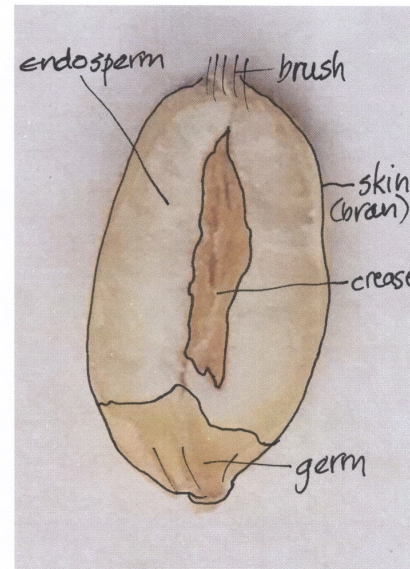




Front view



Side view



Section through side



# Whole edible seeds

- *All whole edible seeds have the same basic parts **bran**, **germ** and **endosperm***
- *Grains are the edible seeds from the same plant family, the **Grass family**. e.g. wheat, rye, barley, sorghum, millet, corn (maize), oats, teff, rice*
- *Buckwheat is the edible seed of a plant in the **Knotweed family***
- *Legumes and pulses are edible seeds of plants in the **Legume family**. e.g. beans, peas, garbanzos (chickpeas), lentils, peanuts, fava beans,*
- *Nuts are the seeds from various trees e.g. almond, walnut, hazelnut,*
- *Edible caraway, cumin, anise, fennel seeds are from plants in the **Carrot family***
- *Mustard seeds are edible seeds of plants in the **Mustard family***
- *Amaranth and quinoa are seeds of plants in the **Amaranth family***







# Preparing seed for milling to flour

- While still on the plant, all seeds are contained inside a *husk, hull, chaff, or shell*, e.g. rice has a *husk*, *spelt wheat* has a *hull*, wheat has *chaff* and almonds have a *shell*. None of these is edible by humans, although some animals can eat them.
- The process for removing the *husk, hull, or chaff* from grains and seeds is known as *threshing*.
- After *threshing*, the *husk, hull or chaff* can be blown away, in a process called *winnowing*.
- Some seeds stay in the husk when threshed and must be released with a *de-hulling machine* e.g. rice, spelt wheat, buckwheat, common barley



Sonora Wheat



CHAFF  
(husk)

blows away

WHOLE GRAINS  
(wheat seeds)  
fall out of chaff  
easily when threshed

WHEAT HEAD  
is  
BEARDLESS

straw

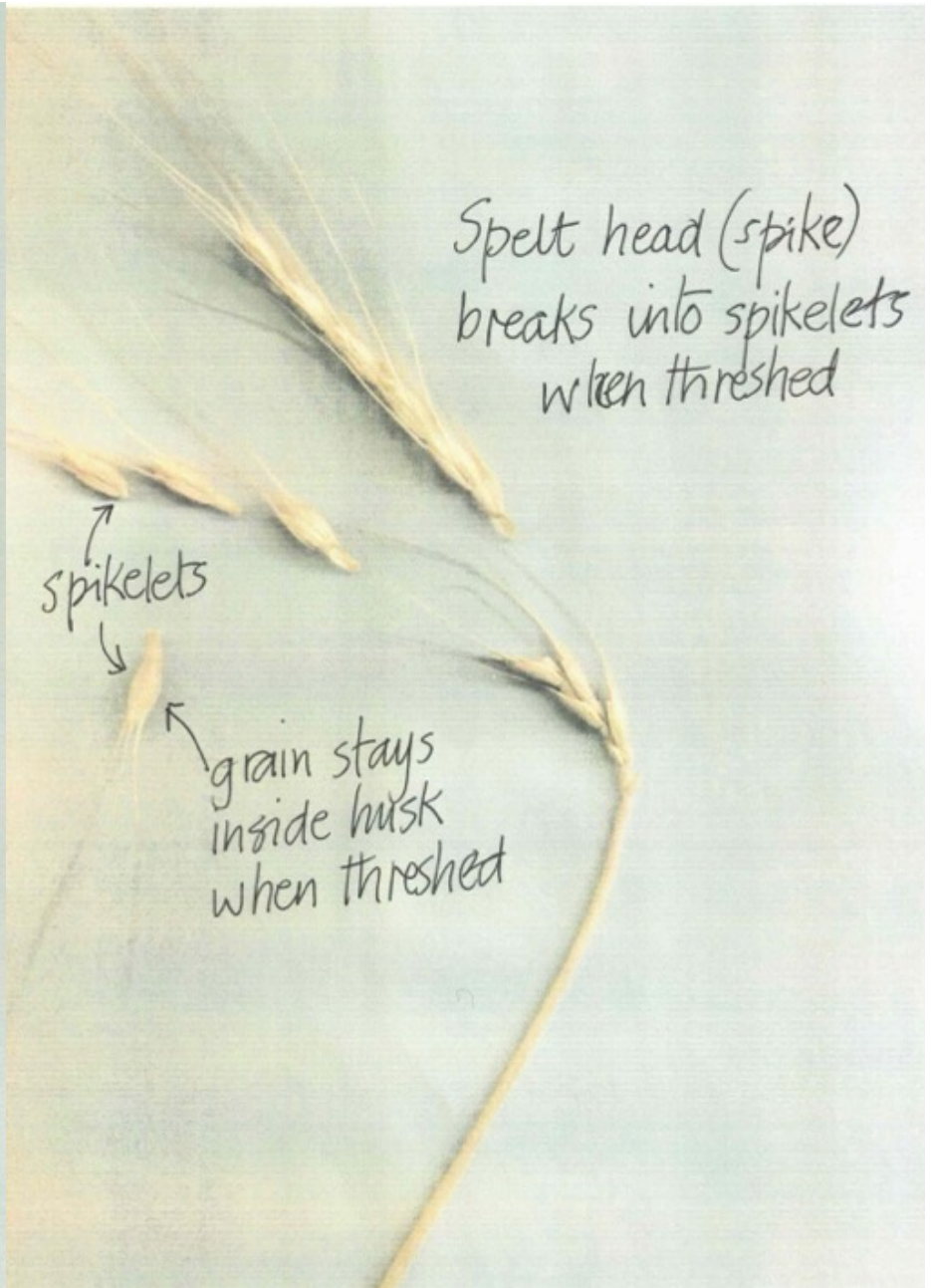
Spelt wheat head or spike



Spelt head (spike)  
breaks into spikelets  
when threshed

↑  
spikelets  
↓

↑  
grain stays  
inside husk  
when threshed



# What is whole grain flour?

## What is whole seed flour?

- *When whole grains are finely ground, usually stone ground, the flour produced contains all the parts of the grain in a mixture: **bran**, **germ** and **endosperm**. This mixture is truly whole grain flour.*
- *The **bran** makes large flakes if the grain is soft and fine and powdery flakes if the grain is hard and brittle. The oily **germ** makes flakes.*
- *The **endosperm** makes a fine powder.*
- *Similarly whole seeds can be ground to a whole seed flour*









Nutrients in Whole Sonora Wheat Flour<sup>1</sup> (*Amounts in grams / 100 grams of whole wheat grain*)

- *Represents the position in the grain, of the most important source of the nutrient*

	<i>Bran</i>	<i>Germ</i>	<i>Endosperm</i>	<i>Total</i>
<i>% of whole grain</i>	12	3	85	100
<i>Fat</i>		•		2.32
<i>Protein</i>			•	12.7
<i>Available carbohydrate (sugars + starch)</i>			•	2.1+ 60.0
<i>Fiber carbohydrate (soluble + insoluble)</i>	•			1.3 + 10.3
<i>Water</i>				10.7
<i>Micronutrients<sup>2</sup> (vitamins + minerals)</i>	•	•		1.1

1. *Medallion Labs. Sample of Sonora stone-ground whole wheat flour*

Whole Sonora Wheat Flour Micronutrients (*Amounts in milligrams / 100 grams of whole wheat grain*)

- Represents the position in the grain, of the most important source of the nutrient

<i>Micronutrient</i>	<i>Amount (milligrams / 100 grams whole grain)</i>	<i>Bran &amp; Germ</i>	<i>Endosperm</i>
<b>Vitamins<sup>2</sup></b>			
<i>Vitamin E</i>	1.40	•	
<i>Thiamine (B1)</i>	0.47	•	
<i>Riboflavin</i>	0.09	•	
<i>Niacin</i>	5.7	•	
<i>Vitamin B6</i>	0.5	•	
<i>Folate</i>	0.057	•	
<i>Pantothenate</i>	0.8	•	
<b>Minerals<sup>1</sup></b>			
<i>Calcium</i>	51.80	•	
<i>Iron</i>	3.36	•	
<i>Sodium</i>	1.66	•	
<i>Copper</i>	0.135	•	
<i>Potassium</i>	417	•	
<i>Magnesium</i>	141	•	
<i>Manganese</i>	4.09	•	
<i>Phosphorus</i>	421	•	
<i>Zinc</i>	4.89	•	
<i>Total</i>	1,061		
<b>Other Micronutrients</b>			
<i>Phytic acid</i>		•	
<i>Choline</i>		•	
<i>Polyphenolics</i>		•	
<i>Phytosterols</i>		•	
<i>Carotenoids</i>		•	•

*Sourdough fermentation makes most of these micronutrients biologically available.*

*Medallion Labs. Stone ground whole Sonora wheat flour*



# Why do bakers want white flour?

- *Stone ground whole grain flour is colored by the flakes of bran and germ, especially if the grain is dark red brown in color.*
- *The part of wheat that gives bread its typical texture is the white endosperm.*
- *Bakers all through history wanted to have flour without the bran and germ, because it made the bread colored and it took away some of the bread texture and loft.*
- *Sifting to remove most of the bran and germ was perfected by about 1800. This left approximately 85% of the wheat grain as endosperm flour with some of the wheat germ oil rubbed in.*

# Sifted whole grain flour



*Sifting removes colored flakes of bran and germ*

# Why did bakers want an even whiter flour, than sifted flour?

- *Around 1880 the Midwestern Great Plains of North America had become a bread-basket, growing millions of acres of hard red wheat.*
- *Before 1880, on the East Coast the wheat was soft and when sifted the bran flaked and was easily sifted off to give a white flour. In the West, the wheat had a light-colored bran, so the sifted flour was white, even if some bran remained.*
- *Bakers saw that the sifted flour from the Mid-Western hard red wheat was dark colored compared with the sifted, soft, or light-colored wheat; it was impossible to remove the finest particles of bran just by sifting. Hard red wheat bran made a powder when stone milled, instead of large flakes that could be sifted off.*
- *At first the farmers growing hard red wheat could not find customers!*



# How do millers make a flour whiter even than sifted flour?

- *For Mid-Western farmers wanting to sell their crop to bakers, they needed to be able to remove absolutely all the dark-colored bran from the sifted flour.*
- *Also, bakers realized that sifted flour turned rancid when stored for longer than a few months and blamed the presence of wheat germ oils.*
- *So, engineers invented the **roller milling method** for making flour that contained only endosperm, and absolutely no bran and no germ; they **made refined flour**.*
- *For whiter than white refined flour, chemical bleaching was introduced in the 1950s*

# What is the roller milling method for making refined white flour?

- *Clean grain is moistened with water and left for a time so that the bran is loosened. The grain is said to be **tempered**.*
- *The tempered grain is then sent between steel rollers that can perfectly peel off the bran from the grain.*
- *The germ is completely cut from the end of the grain as it passes between a second set of rollers.*
- *The remaining endosperm is finely ground to **white refined flour**, between a third set of steel rollers.*
- *Because the grain was moistened at the beginning of the process, the final refined white flour contains more moisture than the original grain. But it stores very well, without any germ oils being present, and pleases bakers because it is not colored by fine bran particles.*
- *Bran and germ are collected separately.*
- *Roller mills were invented and widely used by 1880.*

*The germ and bran is primarily used for animal feed. This strongly supports the concentrated animal feeding operations in the meat and dairy industries.*





# Towards making more wheat available in a hungry world

- *If wheat was presented in the whole grain form instead of as refined wheat flour, we would have 25% more wheat available, and it would be in its natural highly nutritious form*

# Also, rice eaters wanted rice that was white and did not turn rancid

- *Freshly de-hulled rice is brown due to the bran and quickly turns rancid due to the oils in the germ.*
- *Rice eaters wanted white rice that did not turn rancid from the oils in the germ.*
- *The method for rice polishing was introduced at about the same time as refined white flour roller mills, in 1880s.*
- *The rice polishing process completely removes the bran and germ.*

# Refined wheat flour mills had almost completely replaced stone mills by 1900

- *Refined white flour and polished rice were popular with almost everybody*
- *People simply wanted the whiteness and did not know that there were essential nutrients in the discarded bran and germ*
- *Only 76% of the whole grain was extracted for refined flour; the **aleurone** layer immediately under the bran was also removed. Thus, refined flour was whiter than sifted stone ground flour.*
- *Physician Thomas Allinson in England was alarmed and set up his own stone milling business*
- *Hovis® flour was invented by Richard “Stoney” Smith, after separated wheat germ became available. The wheat germ was cooked and added to white flour to make Hovis bread.*



# Making whole grain flour by recombining the roller mill separated bran, germ & endosperm

- *At the beginning of the roller milling process the wheat is moistened, so recombining the bran, germ, and endosperm produces a wet whole grain flour, that turns moldy and rancid very quickly.*
- *To partly solve this problem the oily germ is omitted, and the bran is dried before mixing it with the endosperm, but this is not a truly whole grain flour.*
- *Another solution is to dry and cook the germ to slow down the onset of rancidity, before recombining.*
- *No matter which process is used, the whole grain flour from roller milled grain tastes quite different to freshly milled single pass 100% whole wheat flour.*
- *Making whole grain flour using the roller mill is counterproductive, but in the absence of stone mills this kind of whole wheat flour is normally produced, but it has proved to be unpopular despite the nutritional benefits, because it lacks the taste benefits of freshly stone-ground whole grain flour.*
- *Less than 10% of all roller milled flour is made into reconstituted whole grain flour*

# Diseases and digestive problems appeared increasingly after the introduction of roller milling and grain polishing, leading to the discovery of essential vitamins and minerals in the bran & germ of grains, between 1880 and 1940

- *Constipation and appendicitis were already common after sifted flour became available to most people after 1800, due to sifting off the bran.*
- *The vitamin deficiency diseases beriberi and pellagra also became common after roller milling replaced stone milling by 1900, due to the perfected removal of the aleurone-bran and germ oils.*
- *Vitamins and some minerals in the bran & germ of whole grains were discovered between 1900 and 1930s. By 1940, people knew that bran could prevent constipation, and that the bran and germ contained B-vitamins that could prevent beriberi and pellagra*
- *Many young men were unfit to fight in World War II due to basing diet on refined white flour. So, in 1940s, US and UK governments advised millers to enrich their refined flour with B-vitamins and minerals to prevent beriberi and pellagra, at least.*
- *Beriberi and pellagra were rare again after flour enrichment with the B-vitamins in 1940s*
- *Digestive problems, heart disease, obesity, diabetes and colon cancer continued to increase even after flour enrichment*

# Recognition of dietary fiber & associated nutrients in bran from 1970s onwards

- *In the 1970s the importance of dietary fiber in preventing constipation, heart disease, obesity, diabetes and colon cancer was proved.*
- *The role of other components combined with the non-digestible dietary fiber in the bran and germ, were discovered later.*
- *Polyphenolics in wheat bran are powerful antioxidants that help prevent metabolic disease (obesity, diabetes and heart disease).*
- *Soluble dietary fiber is needed for a healthy microbiome, which also prevents metabolic disease and colon cancer*



# What happened to wheat after the invention of roller milling in 1880?

- *Roller milling to refined wheat flour was specially invented for hard red wheat – the kind that grows best in the continental climate of the Great Plains of Canada and USA*
- *After 1900 most millers no longer had stone mills, they only had roller mills, so millers demanded only hard red wheat from farmers. West Coast and East coast wheat farmers could not sell their softer or light-colored wheat to the millers.*
- *Coincidentally, in 1880 the laws of plant inheritance had been worked out by Mendel. So, wheat botanists, wheat breeders realized that they could systematically breed wheat to be hard red and able to grow well in any place they wished.*
- *Therefore, new hard red wheat varieties were introduced after 1880 that would grow elsewhere than in the Great Plains. These new wheat varieties were made by making crosses between locally grown wheat and hard red wheat from the Great Plains.*
- *Actually, the hard red wheat varieties in the Great Plains had originally come from central Europe and Russia where they had been growing as landraces for millennia.*

# What happened to wheat after the Green Revolution of the 1950s?



- *From 1880 until the 1950s mostly hard red wheat was produced everywhere. The wheat was generally tall at 3 feet or taller and produced at the rate of about 2,000 pounds per acre at the most. It was generally rain fed and fertilized by crop rotation with legumes or pasturing.*
- *The Green Revolution invention was to densely plant short stature (knee high) wheat, in herbicide, and synthetic fertilizer treated fields, and to irrigate, so to produce a consistently very high yield per acre.*
- *Thus, from 1950s onwards the hard red wheat destined for roller milling to refined flour, was also bred to be short by crossing with a mutated very short stature wheat.*
- *By 1970s millers objected to wheat bred just for yield, because the baking quality had declined in favor of yield. In California and elsewhere wheat commissions were set up to test the new wheat varieties for their milling and baking quality before releasing them to farmers.*

# A whole grain rebellion in the 1980s

- *The knowledge that so many essential nutrients were missing in white flour, even after enrichment, plus the poor baking quality of some Green Revolution wheat, led to a significant movement towards stone milling and whole grain breadmaking in the 1980s.*
- *This was the original artisan bread movement & it was whole grain.*
- *Local stores with mills were set up, health food stores sold bulk grains to mill at home, and local bakers were setting up whole grain bakeries. Whole grain baking recipe books appeared. Small kitchen mills became available.*
- *Spelt and Kamut®<sup>®</sup>, heritage wheat that predated roller milling was introduced and sold for whole grain baking at home.*



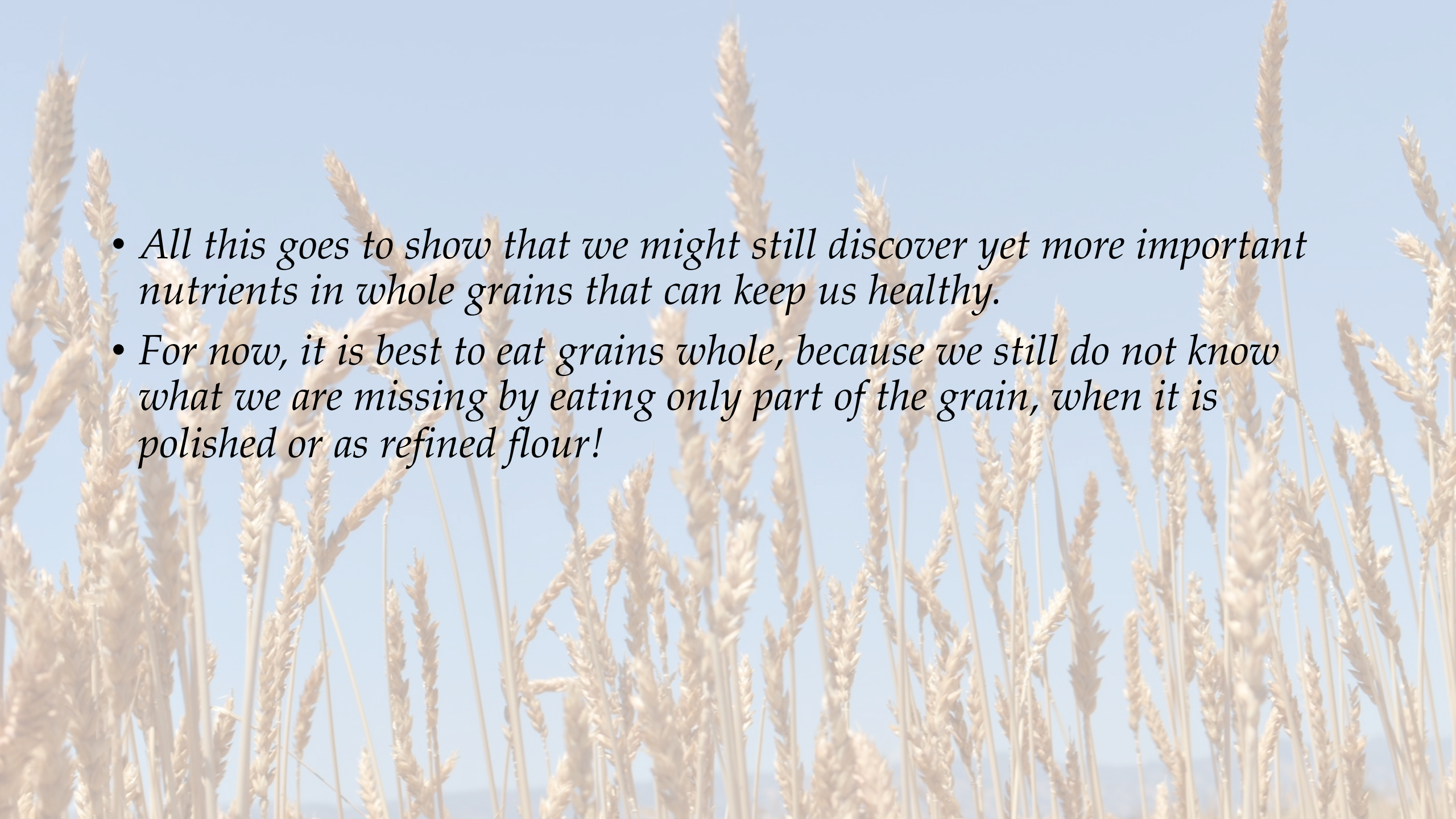
# Heritage wheat selection quietly continued for organic farmers & whole grain baking in 1990s

- *Tall landrace wheat varieties from the Old World were grown for centuries before 1880 and predate all the modern breeder's changes to accommodate refined flour milling and green revolution farming*
- *Organic farmers realized that the Green Revolution wheat was useless for organic agriculture. Instead, old fashioned tall wheat was needed to grow above the weeds and to withstand droughts without irrigation. No herbicides, pesticides or synthetic fast release fertilizers are used by organic farmers.*
- *Whole grains for whole grain flour and bread need to be grown organically so that there are no pesticide residues on the bran and germ.*
- *Whole grain flour can be produced fresh, by stone mills that can be simply set up on any scale, and they can use a very wide range of wheat, grain and seed types.*
- *By 2000, organic farmers had begun to grow and sell old landrace wheat varieties appropriate to their region either as the grain or as whole grain flour independently of the refined flour milling system.*

## The 1990s back-lash against whole grain milling & baking of the 1980s by refined flour millers & bakers back-fired

- *The Bread Bakers Guild of America was formed. It was backed by the refined flour millers and suggested to artisan bakers that they could use organic refined flour without additives (enrichment). Unfortunately, many whole grain artisan bakers did indeed change to using organic refined flour without enrichment; they had not learned the lessons of the discovery of vitamins minerals and dietary fiber in the bran and germ of grains.*
- *Organic refined flour introduced without additives, sounds healthy, but is grossly deficient in the nutrients of the bran and germ.*
- *Popular organic refined flour artisan breads lack whole grain nutrition; not even enriched in most cases.*
- *The effort back-fired when many people began blaming wheat for their ill health, most likely because they were basing their diet on deficient organic refined flour breads.*
- *Atkins published popular diet books that suggested avoiding refined flour.*
- *Gluten free movement appeared and strengthened as more and more organic refined flour without enrichment was consumed.*



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- A field of golden wheat stalks under a clear blue sky. The wheat is in the foreground, slightly out of focus, and the sky is a uniform light blue. The text is overlaid on the image in a black, italicized serif font.
- *All this goes to show that we might still discover yet more important nutrients in whole grains that can keep us healthy.*
  - *For now, it is best to eat grains whole, because we still do not know what we are missing by eating only part of the grain, when it is polished or as refined flour!*