

WHOLE GRAIN WHEAT FLOUR & BREAD

Nutritional values

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Sources

1. Whole Sonora wheat flour and bread determinations: Medallion Laboratories, Minneapolis MN, test results for Whole Grain Connection, 2010. *Other wheat varieties would show similar values.*
2. Vitamins in whole wheat flour: McCance & Widdowson's The Composition of Foods (4th edition) Royal Society of Chemistry 1988.
3. Serving size information: www.choosemyplate.gov/grains
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5. Refined flour enrichment:
www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfcfr/cfrsearch.cfm?cfrpart=137&showfr=1

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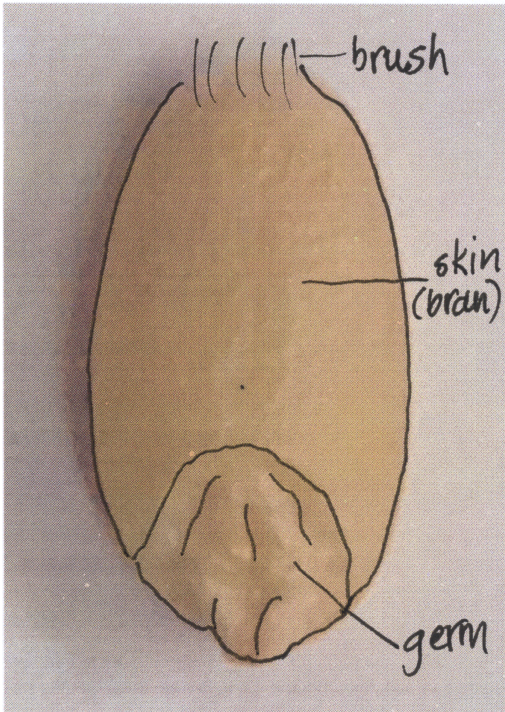
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Sonora wheat head and straw, showing husks that blow away after threshing and winnowing

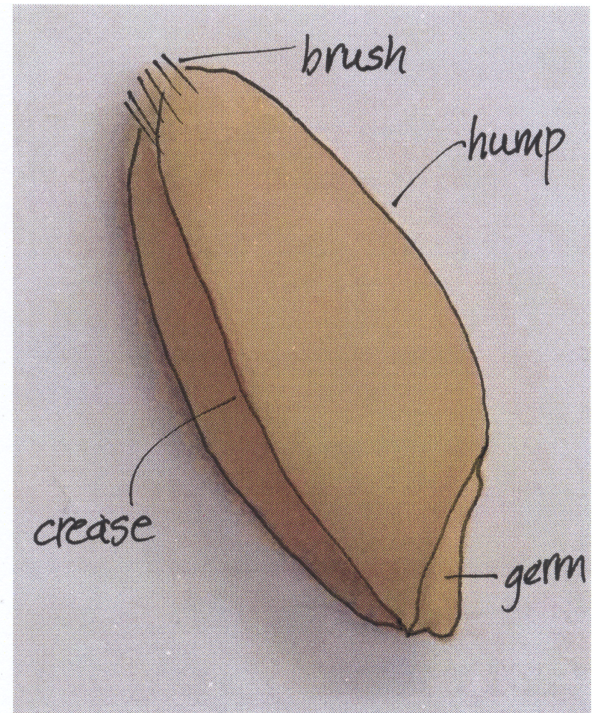


The *husk* is the inedible outermost casing for the wheat grain; the *husk* falls off the grain during the threshing part of grain harvesting. The husk is also known as the *hull* and *chaff*. Some exceptions are einkorn, emmer and spelt wheat. Removing the *husk* or *hull* from these grains requires a de-hulling machine.

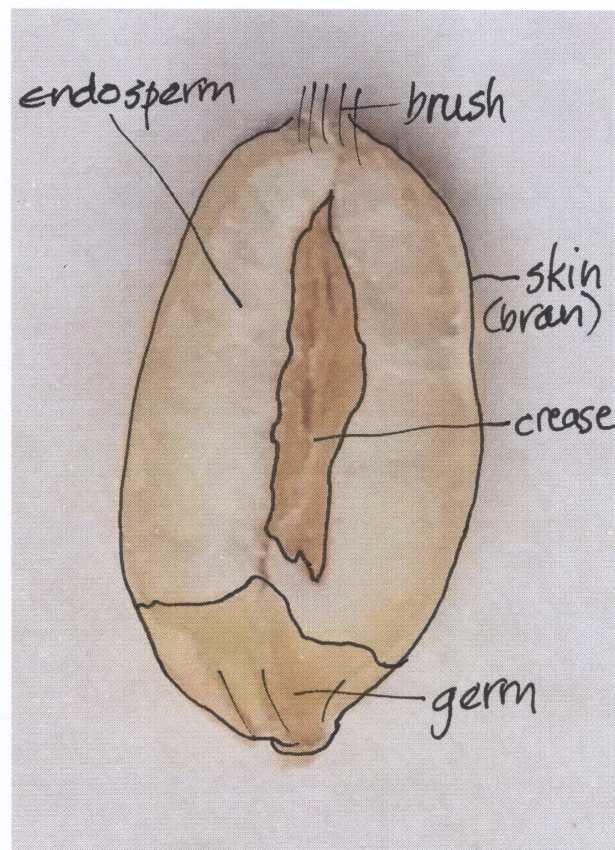
Whole Wheat Grain



Front view



Side view



Section through side

Notes on the whole wheat grain

The *brush*, *hump* and *crease* describe the characteristic physical appearance of the wheat grain

Bran is the thin skin covering the grain; it is the seed coat. Bran is completely edible and supplies essential insoluble fiber, as well as soluble fiber, minerals, B-vitamins and the antioxidant polyphenolic compounds, which are the color and flavor compounds for wheat.

The *wheat germ* contains the embryo for the new plant and is located at the sprouting end of the grain; the germ is rich in essential oils, vitamin E and B-vitamins.

The *wheat endosperm* contains a large store of starch, which serves as the source of energy for the new plant. This starch can be used by the new plant, only if it has access to the vitamins and minerals present in the bran and germ. This is also true for humans. Most of the grain protein is also in the endosperm; this endosperm protein is known as gluten* and has unique properties that are useful in bread-making.

**About the modern view of gluten:*

Celiac disease is very rare. The symptoms are noticed when babies are weaned; they fail to thrive when fed wheat, and their condition improves when wheat is removed from the diet and replaced by other foods. Generally there is damage to the intestines, which heals when wheat is removed from the diet.

Wheat allergies are similar to other allergies in being caused by a protein. In the case of wheat the protein may be gluten from the endosperm, but it could also be from the protein in the germ or bran. The symptoms are watery eyes, runny nose, sneezing, skin irritation and in extreme cases asthma or anaphylactic shock. Rarely, a person experiences an extreme reaction to wheat during or immediately after exercise. However, this reaction has been seen in people who do not have wheat allergy, which suggests that their carbohydrate energy source, say refined and un-enriched wheat flour, or baking powder raised biscuits, could not supply enough of the B-vitamin complex and minerals needed to release energy when exercising vigorously.

Wheat intolerance is manifested by a variety of symptoms, such as diarrhea, constipation, skin problems, lack of energy, and a foggy brain. These symptoms are most likely caused by eating highly refined wheat products as the base of the diet. It is a fashion to produce organic refined flour that is not enriched with B-vitamins and minerals. In any case even the ubiquitous enriched refined wheat flour is deficient in many of the beneficial nutrients to be found in the whole grain. Therefore it is not surprising that people who base their diet on refined flours will feel unfit and possibly distinctly ill when eating refined wheat.

The degree to which enrichment of refined flour is enforced in Europe varies. Also some millers and bakers feel the responsibility to at least enrich their refined wheat products with the major B-vitamins and minerals. This could be the explanation for the observation that bread eaten while travelling in Europe does not cause the symptoms felt from eating some American bread.

Nutrients in Whole Sonora Wheat Flour¹ (*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>Micronutrients² (vitamins + minerals)</i>	•	•		1.1

Notes: Macronutrients in whole wheat

Macronutrients are fat, protein and carbohydrate, usually measured in grams / 100 grams of food

Micronutrients are vitamins, minerals and other phytonutrients present in very small or micro amounts usually measured in milligrams / 100 grams of food

Fat is used in the diet as a concentrated source of energy; it supplies 9 Calories / gram. Fat from wheat germ is associated with essential oils, choline, and vitamin E

Protein is used in the diet as a source of amino acids for building protein. Wheat protein, which is mostly in the endosperm and known as gluten, is not considered to be a complete protein because it is relatively low in the amino acid lysine. Legumes (peas, beans and lentils) are relatively rich in lysine, so that including a serving of legumes each day increases the value of the protein from the wheat, and from the legumes. Protein can also be an energy source especially if carbohydrate intake is low; it supplies 4 Calories / gram.

Available carbohydrate in wheat consists of the starch and small amounts of sugars, which is found almost entirely in the endosperm. Starch and sugars are regarded as available because they are easily digested and converted to energy; starch and sugars supply 3.75 Calories / gram. Available carbohydrate requires a supply of B-vitamins and minerals from the wheat bran and germ, for proper assimilation in humans. Without those B-vitamins we feel tired and some of the carbohydrate is turned into fat deposits instead of supplying our energy needs. Acute absence of these minerals and vitamins leads to deadly deficiency diseases, and chronically low levels lead to Western diseases such as obesity, diabetes and cardiovascular disease.

Fiber carbohydrate from wheat is found in the bran and is the main source of insoluble dietary fiber in the diet, as well as some soluble fiber. The insoluble dietary fiber is indigestible; it is needed to carry food all the way through the digestive tract, and favors regular elimination. Soluble fiber is also not digested, but is used by the intestinal microorganisms to promote a healthy microbiome, which benefits the immune system. Generous amounts of dietary fiber from wheat and other grains, in combination with dietary fiber from legumes, fruits and vegetables, greatly reduces the risk for constipation, diverticulitis (appendicitis) and colon cancer. Some energy is obtained from soluble fiber when the breakdown products enter the bloodstream and this is estimated to be: 2 Calories / gram. These breakdown products from soluble fiber, short chain fatty acids, also help maintain a healthy blood cholesterol profile.

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 & Germ</i>	<i>Endosperm</i>
Vitamins²			
<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	•	
Minerals¹			
<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		
Other Micronutrients			
<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.

Notes on micronutrients in whole wheat grain

Vitamin E is an antioxidant, and is important for cardiovascular health and healthy human reproduction.

Thiamine, or vitamin B-1, is essential for the proper assimilation of digestible carbohydrates such as starch and sugar. When supplies are inadequate, carbohydrates are converted to fat deposits instead of supplying energy. Thiamine is stabilized by acidic sourdough leavening and destroyed by alkaline baking powder leavening. Lack of thiamine leads to the deficiency disease, beri-beri.

Riboflavin is part of the B-vitamin complex and is important for reproduction and growth and for the health of the eyes, skin and nerves.

Niacin is part of the B-vitamin complex and keeps the skin, digestive system and nerves healthy. Lack of niacin leads to the deficiency disease known as pellagra. Whole wheat is a very good source of niacin. Tryptophan in whole wheat adds to the niacin availability by being converted to niacin by vitamin B-6.

Vitamin B-6 helps to convert tryptophan into niacin. B-6 is especially important for babies who have convulsions if they have insufficient vitamin B-6 in their diet.

Folate or folic acid deficiency results in a smooth red tongue and diarrhea, as well as a blood disorder, macrocytic anemia. It is most important in the prevention of spina bifida in babies and preventing Alzheimer's disease. Vitamins B-12 and B-6, and vitamin C work together with folic acid to build proteins, which explains the importance of folic acid in healthy reproduction.

Pantothenic acid, like all the B-complex vitamins, is important for the maintenance of healthy skin, digestive system and nerves. Pantothenic acid is involved with the complex of riboflavin, thiamin and niacin as well as the minerals phosphorus, magnesium, and manganese in the proper production of energy in the body, so preventing the deposit of unwanted fat.

Iron is an essential part of hemoglobin in the red blood cells. Simple anemia results from too little iron in the diet. Sourdough leavening helps to make iron and other minerals such as zinc in whole wheat available; the acidity allows the breakdown of phytates in bran, which bind iron.

Zinc is part of the hormone insulin and is therefore concerned with the proper release of energy from carbohydrates. Zinc is also important in healthy reproduction.

Magnesium makes an important contribution to bone formation and health; it is also needed in all cells together with the B-complex of vitamins that releases energy from glucose.

Potassium is essential in the body fluids and helps to maintain a healthy blood pressure.

Phosphorus together with calcium and magnesium is essential for healthy bone structure. Phosphorus is also an important component of many other compounds in the body, such as the lipid choline found in nerve cells. Diets low in the minerals calcium, magnesium and phosphorus often cause dental and jaw deformities. The phytic acid and phytates in wheat bran are an important source of phosphorus and also of myo-inositol phosphates. Sourdough breadmaking breaks down phytic acid so that it releases minerals such as iron and allows them to be completely bioavailable. Supplemental myo-inositol phosphate has been used together with folic acid and seen to be a means of further reducing the incidence of spina bifida in babies.

Choline is a phospholipid found in wheat germ that is essential for growth and it prevents fatty infiltration of the liver.

Carotenoids provide yellow color and antioxidant activity protective to the eyes and skin especially. Lutein is the most important carotenoid found in wheat. Modern bread wheat varieties, which have been bred for white flour production are generally low in carotenoid content. Varieties that produce yellow colored whole grain flour such as einkorn, durum wheat and Sonora wheat have the highest amounts of carotenoids present.

Phytosterols are found in wheat germ oils. They have cholesterol lowering properties and are likely protective against colon, breast and prostate cancers.

Polyphenolic compounds are the antioxidant, color and flavor compounds found in all plant foods, and especially in fruit and seed skins, such as wheat bran. Polyphenolic compounds are also highly concentrated in wheat germ. The beneficial effect of wheat bran against colon cancer is attributed to the presence of a high concentration of polyphenolic compounds, which are likely released into the colon as a result of bacterial fermentation. The broad description of *polyphenolic compounds* includes the alkyl resorcinols, which are recognized as anti-cancer, and some lignans, which are phytoestrogens capable of protection against cancers and cardiovascular disease.

FLOUR

Comparison of Nutrients in Whole, Sifted Stone Ground & Refined Wheat Flour

• represents position in grain with highest concentration of nutrient

<i>Flour type</i>	<i>Approximate % of whole grain (= extraction rate)</i>	<i>Fat</i>	<i>Protein</i>	<i>Available (digestible) Carbohydrate</i>	<i>Fiber Carbohydrate</i>	<i>Micronutrients (vitamins & minerals)</i>
Whole wheat flour	100	•	•	•	•	•
Sifted or bolted whole wheat flour	85	•	•	•	•	•
Enriched* refined flour	76		•	•		•
Organic refined wheat flour	76		•	•		

* Thiamine, riboflavin, niacin, folic acid, iron added for enrichment

Notes on comparison of wheat flour types

Whole wheat flour contains all of the nutrients in the whole grain.

Sifting or bolting flour preferentially takes out the bran and germ, which do not grind down easily to such fine particles as the endosperm. Soft wheat tends to produce large bran flakes, whereas the more brittle hard wheat types, produce smaller bran flakes. Nutrients found in the bran and germ, are therefore preferentially removed during sifting or bolting.

Refined flour is roller milled to remove all of the bran and germ from white (endosperm) flour. Therefore all the nutrients in the bran and germ are absent from this flour. There is a legal requirement to enrich refined flour with thiamine, riboflavin, niacin, folic acid and iron. However, the requirement is loosely applied in the USA so that sifted flours and organic flours need not comply. The application of enrichment varies between countries.

Organic refined flour is roller milled to remove all of the bran and germ from white (endosperm) flour. Therefore all the nutrients in the bran and germ are absent from this flour. No additives are mandated so organic refined flour is generally not enriched.

Whole Wheat Bread

Loaf weighing 821 grams contains 500 grams whole wheat flour

Slice contains 28 grams (one ounce serving) whole wheat flour; slice weighs approximately 50 grams



Macro-Nutrients¹ in whole Sonora wheat bread

<i>Nutrients</i>	<i>Nutrients in grams / 100 grams whole Sonora wheat bread* (= 2 slices)</i>	<i>FDA Daily Value (grams)</i>	<i>% Daily value from 100g bread (= 2 slices)</i>	<i>% Daily value from 300g bread (= 6 slices or total for one day)</i>	<i>Nutrients</i>
<i>Available Carbohydrate</i>	37.70	275	13	41	<i>Available Carbohydrate</i>
<i>Fiber carbohydrate</i>	7.00	25**	28	84	<i>Fiber carbohydrate</i>
<i>Fat</i>	1.53	65	2	7	<i>Fat</i>
<i>Protein</i>	10.20	50	20	61	<i>Protein</i>
<i>Water</i>	42.39				<i>Water</i>

*Micronutrients weigh approximately 1 gram / 100grams in a slice of bread.

**This is a minimum value for fiber. We generally need 40 grams / day

Calories¹ from Whole Sonora wheat bread

<i>Calories from 100 grams whole Sonora wheat bread</i>	<i>Daily Value for Calories (Average adult value)</i>	<i>%Daily Value for Calories from 100 grams whole Sonora wheat bread</i>	<i>%Daily Value for Calories from 300 grams whole Sonora wheat bread</i>
<i>2 slices</i>		<i>2 slices</i>	<i>6 slices</i>
232	2000	12	35

Whole Sonora Wheat Bread Micronutrients¹ (*Amounts in milligrams / 100 grams of bread*)

<i>Micronutrient (vitamins & minerals)</i>	<i>Nutrients (milligrams from 100 grams bread; = 2 slices)</i>	<i>FDA Daily Value (milligrams)</i>	<i>% Daily Value (milligrams from 100g bread; = 2 slices)</i>	<i>% Daily Value (milligrams from 300g bread; = 6 slices, or total for one day)</i>	<i>Micronutrient (vitamins & minerals)</i>
<i>Vitamin E (IU)</i>	0.271	30	0.9	3	<i>Vitamin E (IU)</i>
<i>Thiamine (B1)</i>	0.350	1.5	23	69	<i>Thiamine (B1)</i>
<i>Riboflavin</i>	0.0700	1.7	4.1	12	<i>Riboflavin</i>
<i>Niacin</i>	4.894	20	24.47	73	<i>Niacin</i>
<i>Vitamin B6</i>	0.184	2	9.2	28	<i>Vitamin B6</i>
<i>Folate</i>	0.02264	0.4	5.66	17	<i>Folate</i>
<i>Pantothenic acid</i>	0.440	10	4.4	13	<i>Pantothenic acid</i>
<i>Calcium</i>	34.5	1,000	3.45	10	<i>Calcium</i>
<i>Iron</i>	2.69	18	14.94	45	<i>Iron</i>
<i>Sodium</i>	242	2,400	10.08	30	<i>Sodium</i>
<i>Copper</i>	0.371	2	18.55	56	<i>Copper</i>
<i>Potassium</i>	232	3,500	6.63	20	<i>Potassium</i>
<i>Magnesium</i>	88.4	400	22.1	66	<i>Magnesium</i>
<i>Manganese</i>	2.56	2	128	384	<i>Manganese</i>
<i>Phosphorus</i>	264	1,000	26.4	79	<i>Phosphorus</i>
<i>Zinc</i>	2.75	15	18.33	55	<i>Zinc</i>

