



Baking Science...

Field to Flour

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Food Grains

*All beginnings
are difficult.*

Aristotle



Art: "Wheat" Thomas Hart Benton.
1967.

Nat'l Museum of American Art.
Washington, D.C.

Long before there were loaves...

- There had to be *agriculture*—
Over 10,000 years ago
Neolithic People began
cultivating (not just gathering)
good tasting wild grasses...
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Food Grains...

...became the base of life.

Q: What are the “food grains” that fuel people worldwide?

Where did those grains begin?

Wheat... West Asia/Iraq, Southeast Turkey

Rice... Asia

Corn (maize)... Americas (north, south, central)

Barley... Europe

Oats... Scotland/Ireland

Rye... Northern Europe

Sorghum... Africa

More at: *Exploring Kansas Crops*
Kansas Agriculture in the Classroom. 2002
Download @ www.kswheat.com

Someone discovered...

...goat grass (*Aegilops tauschii*)

- **Get a map!**

Find the Tigris & Euphrates River Valley
“The Fertile Crescent”—
Syria, Turkey, Iraq, Iran

Photo: Kansas State University,
Wheat Genetic Research Center.
Learn more: www.wgrc.ksu.edu



...And, the science of wheat breeding began

1. Natural crosses or **hybrids** became early wheat
goat grass X einkorn (28 chromosomes)
2. Humans **select** grains that taste good, grow well,
and then
cultivate them; more crosses occur
3. *Goat grass (Aegilops tauschii) (14 chromosomes)*
X Emmer (Triticum dicoccum) (28 chromosomes)
Bread wheat (42 chromosomes)

Ex: Goat grass provides *glutenin*,
essential for elastic bread dough

10,000 years of Wheat

10,000 years ago—early farmers gathered & grew *goat grass and einkorn*, the parents of wheat.

4,700 years ago—Chinese grew wheat

2,500 B.C.—Fifth dynasty Egyptians baked bread with emmer wheat

85 B.C.—Water mills are first used in Asia Minor

1086—The Doomesday Book, England, lists 5,624 mills in England

1180—Windmills mentioned in France, England and Syria

10,000 years of Wheat-cont.

- 1600's**—American Colonists mix native maize (corn) with wheat and rye flour for “Third Bread” to make imported wheat flour go further
 - 1777**—Wheat first grown in U.S. as hobby crop
 - 1785**—Oliver Evans invents first automated roller flour mill in U.S.
 - 1874**—Russian Mennonites introduce Turkey Red wheat in Kansas (hard red winter wheat)
 - 1990s**—Kansas begins increasing production of hard white winter wheat
 - Today**--There are over 30,000 varieties of wheat—it is the favorite cereal grain in the world.
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8,000 years of bread

- 8,000 years ago**—Swiss lake dwellers baked flat “cakes” on hot stones
- 2,000 B.C.**—Egyptians discover yeast; bread fed Hebrew slaves building pyramids
- 300 B.C.**—Romans create quantity flour mills; bakers highly regarded
- 200 B.C.**—Romans open bakery stores—bake for 20,000 people daily
- 100 A.D.**—First baking school in Rome
- 610 A.D.**—Romans and Monks in southern France credited with first pretzel. Leftover dough shaped as “pretiolas,” a reward for children learning prayers
- 1240**—Bread used as plates (trenchers), napkins, containers, oven mitts... food
- 1762**—French 4th Earl of Sandwich, John Montagu, creates the sandwich while gambling
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8,000 years of bread-cont.

- 1800**— Baking soda becomes available; lumps of “sourdough” starters carried by pioneers and prospectors settling the Western U.S.
 - 1850**—White House installs first range, but no heat control in oven
 - 1857**—Louis Pasteur discovers yeast is what makes dough rise
 - 1859**—Baking powder becomes available
 - 1868**—Yeast grown and harvested for first time by James Gaff and Fleischmann brothers
 - 1925**—Sliced bread introduced in stores.
 - 1942**—Dry yeast is developed; helps feed soldiers in the WWII
 - 1980s**—Table top bread machines introduced to American homes
 - Today**, healthy people still get 55% of their calories from carbohydrates
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Wheat is NOT just Wheat

Today, thousands of wheat varieties are organized by ***class***.

Classes are formed based on:

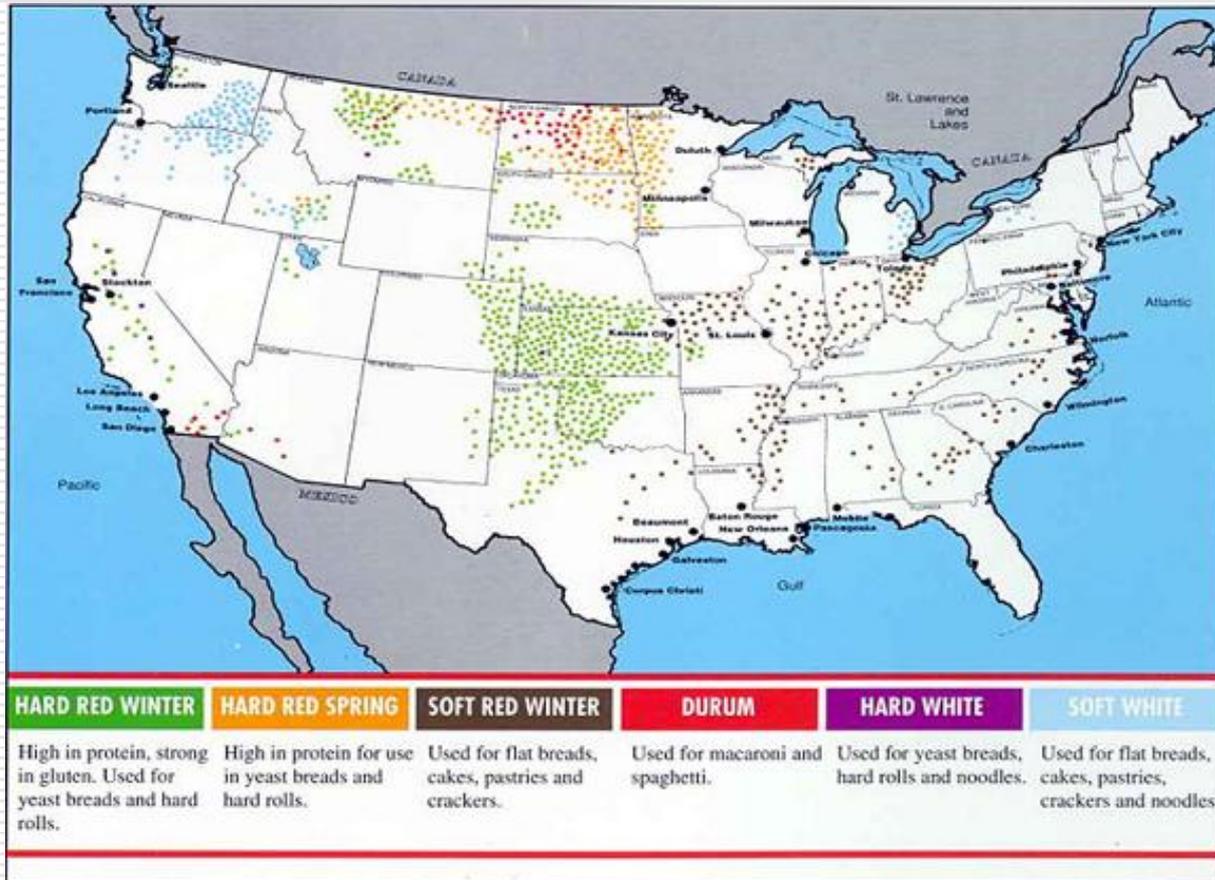
- Growing season (*winter or spring*)
- Bran color (*red or white*)
- Kernel hardness (*hard or soft*)

There are six classes:

- Hard Red Spring
- Hard Red Winter Wheat
- Hard White Wheat
- Soft White Wheat
- Soft Red Winter
- Durum Wheat



Classes of U.S. Wheat



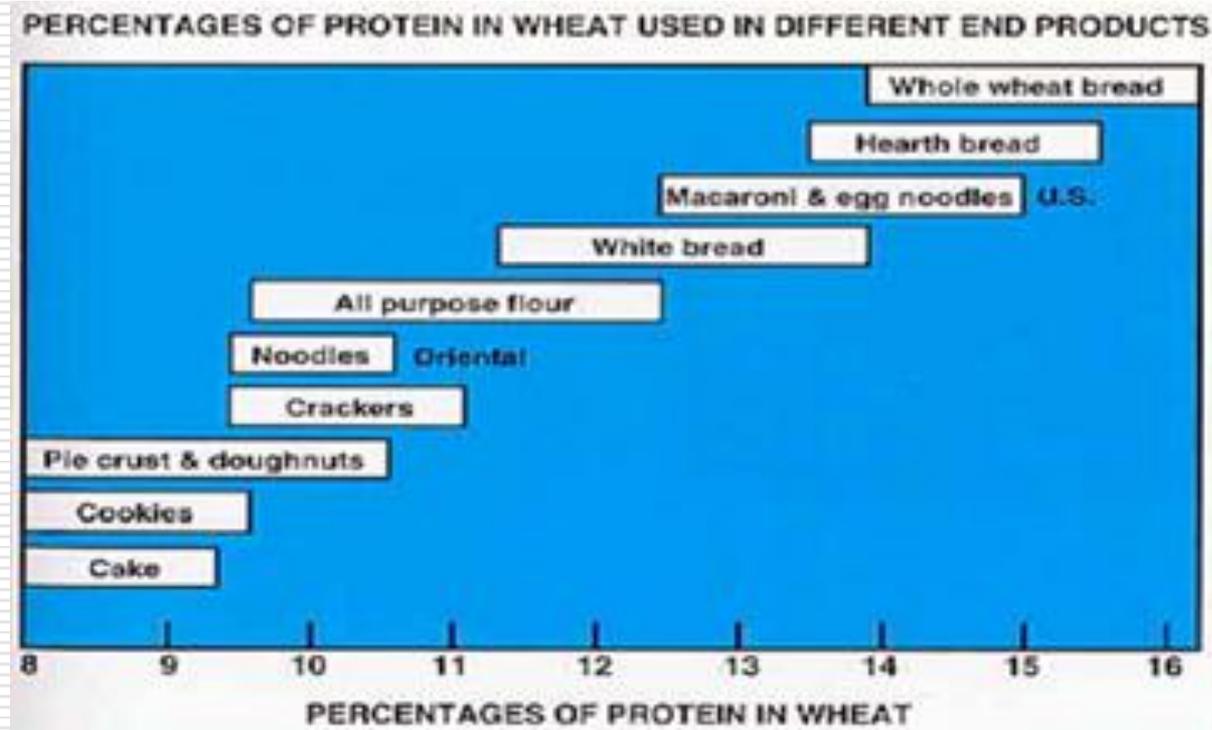
What Wheat for What Products?

Kernel hardness is just one way to tell how much ***protein*** will be in a wheat, and therefore how much will be in the flour.

Hard wheat= medium to higher protein flour stronger gluten strength

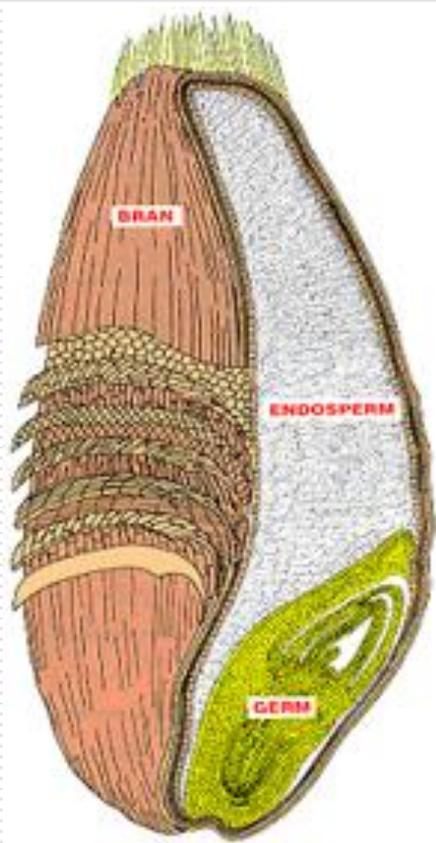
Soft wheat= lower protein flour weaker gluten strength

Wheat Utilization



Blending of wheats is done to achieve the best flour for an end-product use.

Where's the Flour?



- **Whole grain** flour contains all grain parts
- **Refined, enriched** flours are made from the endosperm only
- **Endosperm (83% of kernel)**
Energy for plant growth
Carbohydrates; protein for people
- **Bran layers (14.5% of kernel)**
Protects seed
Fiber, B-vitamins; minerals
- **Germ (2.5% of kernel)**
Nourishes seed
Antioxidants, Vitamin E, B-vitamins

Learn more at: www.wheatfoods.org www.namamillers.org

Flour Milling Today



Mennel Milling

Courtesy of www.namamillers.org

Milling is Science

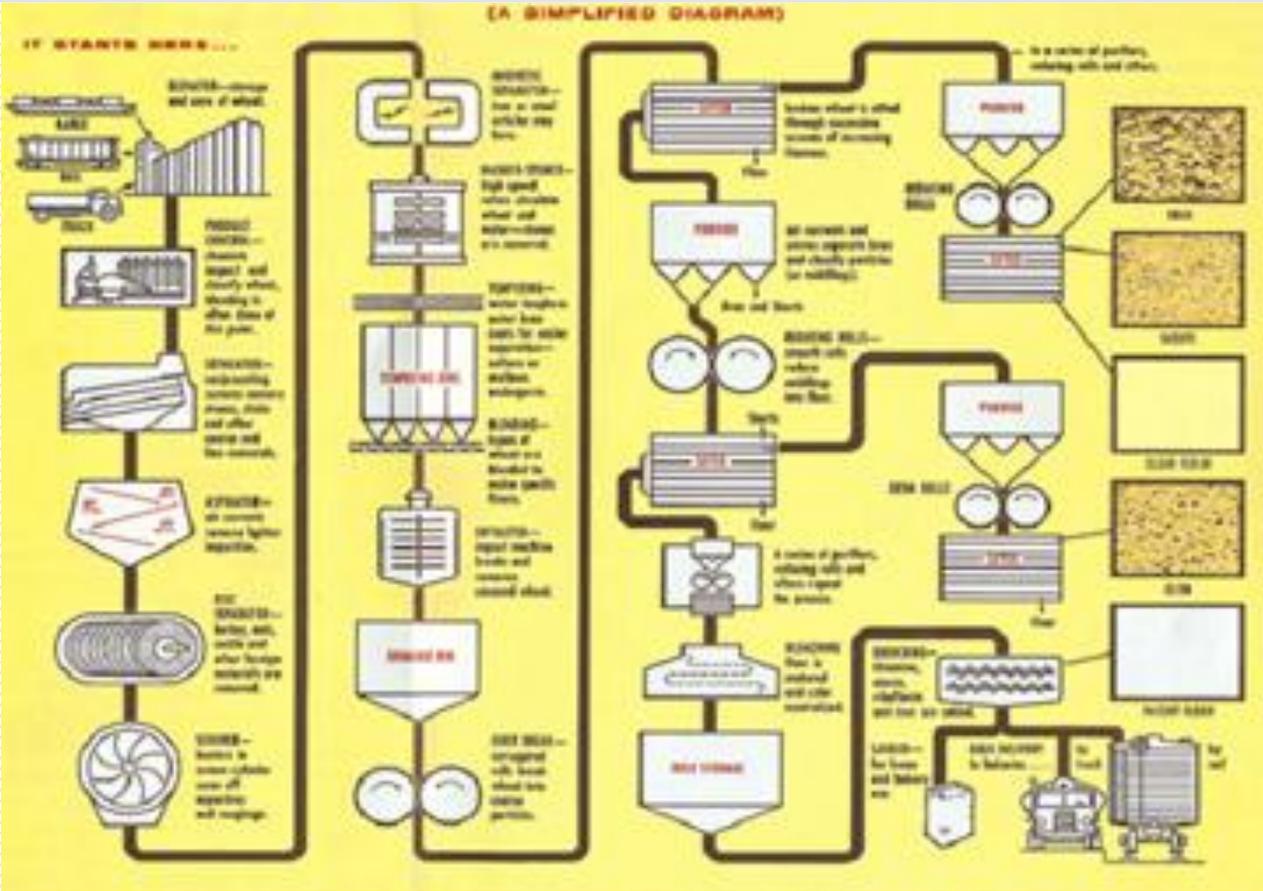
Flour is NOT Just Flour

- Flour is the main, and most important ingredient in baked goods.
 - Millers work with bakers to produce the right flour for the baker's products, equipment, environment, and cost factors
 - Flour is responsible for:
 - Structure--holding and expanding with leavening gases
 - Texture
 - Binding all ingredients
 - Flavor
 - Nutrition
 - Flour cannot be exactly the same every year due to weather factors.
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Many factors affect flour's quality

- The wheat's ***environment***.
climate/weather; soil type & fertility
 - The wheat ***variety*** grown.
Each variety has different protein quality & quantity, starches and enzymes.
 - The wheat's milling quality.
Kernel structure, ease of milling, screenings loss, starch damage, flour yield, flour granulation, grinding power
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How Flour is Milled



Milling Steps

Wheat roller mills...

- Clean
- Temper (moisture added)
- Remove bran
- Remove germ (at right)
- Extract flour from endosperm
- Further separate, sift

...to produce flour



More at: www.namamillers.org

Filling flour
bags at mill.



More at:
www.namamillers.org

Hard Wheat Flours

About 75 lbs of *white* flour comes from 100 lbs. of wheat
The flour comes from the wheat's endosperm (see *Kernel diagram*)

The extracted white flour is then *separated* into *grades*.

Grades of hard wheat flour are called:

- **Straight grade flour** (100% of the flour separation)
- **Patent flour** (70 - 80% of separation)
Second clear flour = the 20-30% left
- **Short patent flour** (60% of separation)
First clear flour = the 40% left
- **High gluten flour** (comes from high protein wheat = 60% of separation)

Learn more: ***From Wheat to Flour.***

www.namamillers.org or www.wheatfoods.org

Soft Wheat Flours

- ***Pastry flour***

Made from 100% of the soft wheat flour separation

Soft red or white wheats used Flour Protein = 8-9%

- ***Cake flour***

60 to 70% of the separation of soft red wheat

chlorine used to bleach for better cakes Flour Protein = 7-8%

- ***Pie flour***

Unbleached pastry flour made preferably from soft white wheat Flour Protein=7-9%

- ***Whole wheat pastry flour***

Milled from soft white or red wheat—white wheat lends a lighter color and flavor Flour Protein = 7-9%

Wheat and Flour Type	Flour Uses	Protein	Dough Strength	Water Absorption	Mix Time	Gluten Formig
Hard Spring High Gluten Strong Patent Spring Patent	Bagels, Hearth brds Thin pizza Pizza crust Hearth bread Breads Rolls	12-14% 13.4-14.4% 12.8-13.2% 12.4-12.8%	High	High 60-65%	Long Mix Time 12-14 minutes High gluten forming	
Hard Winter Winter patent All purpose	Pan breads Artisan bread Sweet dough Thick crust Pizza Quick breads Cookies	10-12% 11-12% 10-11%	Med	Medium 50-60%	Medium Mix Time 8-12 minutes Medium gluten forming	
Soft Winter Pastry Cake	Cookies Brownies Sheet cakes High Ratio cakes; angel	7-9% 8-9% 7-8%	Low	Low	Short mix time Low gluten forming	

Unbleached vs. Bleached Flour

- Freshly milled (“green”) flour will not produce consistently good quality baked goods.
 - Flour naturally ages or oxidizes if stored 8 to 12 weeks.
 - Oxidation improves baking quality, producing finer textured, whiter products.
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Unbleached vs. Bleached Flour-cont.

- “Bleached” flour: Food technologists have developed FDA approved chemical bleaching and maturing agents to improve baking qualities and speed oxidation.
 - “Unbleached” flour: no maturing agents are added. Bread flour is generally unbleached; all purpose flour may be either.
 - *Enriched* bleached or unbleached have equal nutritional value
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Self-Rising Flour

- Early 1900's American "convenience mix" for home bakers
 - All-purpose flour with baking powder and salt added.
 - Best for biscuits, some muffins, pancakes or waffles
 - If substituting for all-purpose, omit the baking soda or powder and salt called for in the recipe.
 - Not recommended for yeast breads.
 - Substitution:
1 cup flour + 1 ½ tsp. baking powder + ½ tsp. salt
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Why is Flour Enriched?

- In milling white flour, the bran and germ are left behind...and many nutrients.
 - Enriching flour means...
thiamin, riboflavin, niacin, iron and folate are added back into the flour at levels equal to or higher than they naturally occur in wheat.
 - Flour may be *fortified* with calcium (a nutrient NOT naturally high in wheat)
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Why is Some Flour “malted?”

- Malted barley flour is milled from sprouted barley
 - Supplements wheat’s natural enzymes to make better yeast-raised products
 - Malted barley flour is not added to whole wheat flour, all purpose flour or cake flour
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Ascorbic Acid in Flour

- High protein flour may have ascorbic acid (Vit. C) added as a maturing agent to produce better volume and crumb structure in the bread
 - The Vit. C is lost in the high heat of baking
 - Ascorbic acid may replace benzoyl peroxide, which is no longer used in bread flour
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Family Flour

- Family flour may be: all purpose, bread, cake, whole wheat, 50/50, pastry or non-wheat flours
- How much protein? Check the label for where the flour milled—is it milled from “spring” or “winter,” “soft” or “hard” wheat?
- Whole wheat flour: Is it a “white” bran coat or a “red” bran coat--White whole wheat is a lighter color & sweeter. Red whole wheat is stronger flavored and darker.
- *All these factors make a difference in what foods it will bake the best. Look at the flour chart for help.*

More at: www.homebaking.org

Non-Wheat Baking Ingredients

- **Barley**—may be pearled (quick or medium), rolled, flour
 - **Amaranth, flax, sorghum, quinoa, buckwheat, triticale, brown rice and more** can be flour, rolled grain, meal, groats
 - **Oatmeal** is wholegrain (rolled instant, quick, old-fashioned, steel cut, Scottish); oat flour; groats
 - **Corn**—*degerminated* (germ removed and enriched) or *wholegrain* meal or flour; may be self-rising too
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Non-Wheat Baking Ingredients-cont.

- **Rye** flour or rolled; may be whole grain or not; dark, medium or light
- **Soy** flakes, flour (may or may not be defatted), grits, protein isolate
- **Vegetables, beans, legumes, nuts** may be ground and flour-like (potato, garbanzo, peas, lentils and more)

Visit: www.homebaking.org Links: Bobs Red Mill, King Arthur, Hodgson Mill for a variety of non-wheat flours, meal and more

Baking with Non-Wheat Ingredients

- Non-wheat flour, meal, rolled grains, bran and germ add **flavor, texture, nutrient variety, and fiber**
 - They must be supported with high-gluten strength wheat flour or added gluten in yeast breads
 - Substitute non-wheat flour or meal at levels totaling 5 to 25% of total flour weight
 - Pre-soak or cook cracked wheat/grains, grits, rolled grains, bulgur
 - Water may need to be added or reduced if using cooked grains
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Food Labels for Grain Foods

Look for:

- **Product name, manufacturer, dates**
- **Net weight**
(how much food you get in package)
- **Ingredient List** - listed most to least
- **Advertising or influences to buy**

Nutrition Facts Label:

- Look at Total Carbohydrates
How much are sugars? How much dietary fiber?

Health claim(s)

(NOT advertising; FDA regulates)

—EX: Whole grain claim

- Must contain 51% or more whole grains by weight
- Must be low in total fat

More about food labels @ www.cfsan.fda.gov/label.html

Nutrition Facts

Serving Size (54g)

Servings Per Container

Amount Per Serving

Calories 100 **Calories from Fat** 30

% Daily Value*

Total Fat 3.5g **5%**

Saturated Fat 0.5g **3%**

Cholesterol 15mg **5%**

Sodium 200mg **8%**

Total Carbohydrate 15g **5%**

Dietary Fiber 1g **5%**

Sugars 3g

Protein 3g

Vitamin A 2% • Vitamin C 0%

Calcium 6% • Iron 4%

*Percent Daily Values are based on a 2,000 calorie diet. Your daily values may be higher or lower depending on your calorie needs:

Calories: 2,000 2,500

Total Fat Less than 65g 80g

Saturated Fat Less than 20g 25g

Cholesterol Less than 300mg 300mg

Sodium Less than 2,400mg 2,400mg

Total Carbohydrate 300g 375g

Dietary Fiber 25g 30g

Calories per gram:

Fat 9 • Carbohydrate 4 • Protein 4

Enriched and Wholegrain Grain Foods are Nutrient-Packed

- Complex carbohydrates
 - Muscle and brain fuel
 - Endurance
 - Energy
 - Soluble and insoluble fiber
 - B vitamins
 - Folic acid
 - Thiamin
 - Riboflavin
 - Niacin
 - Iron
 - Protein
 - Whole grains—even more phytonutrients (antioxidants), minerals and vitamins, dietary fiber
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Get the FACTS about carbs

We gain weight because...

...we eat too many calories, and burn too few.

Check it out for yourself—everybody eats differently.

- Are you too heavy? Calculate your BMI.
www.thebeehive.org/health OR
www.nhlbisupport.com/bmi
 - Keep a food and exercise record for a couple weeks.
Are **your** extra calories from fat, protein or carbs?
Are you eating or drinking too many SUPER servings?
Do you “eat” the Dietary Guidelines? www.eatright.org
Are you active enough? 30 to 60 minutes (10,000 steps)
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More about grains, nutrition, milling and baking careers at:

- American Institute of Baking - www.aibonline.org
 - American Institute of Cancer Research - www.aicr.org
 - Get on the Grain Train - www.usda.gov/cnpp
 - Home Baking Association - www.homebaking.org
 - Kansas State University Ext. Healthful Whole Grains
www.oznet.ksu.edu/library/fntr2/MF2560.pdf
 - Kansas State University
Agronomy-www.oznet.ksu.edu/fieldday/kids/crops
Grain Science-www.oznet.ksu.edu/dp_grsi
 - **Kansas Wheat Commission** - www.kswheat.com and
www.wheatmania.com + many more great links!
 - North American Millers Association - www.namamillers.org
 - Retail Bakers of America - www.rbanet.com
 - The Bell Institute, General Mills
www.generalmills.com/wholegrain
 - Wheat Foods Council - www.wheatfoods.org
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