Chapter 10: Bread, Cakes & Pastry

The goodness that comes from yeast and flour!

"The dog ate my homework."

An Inferiority Complex Carbohydrate

Flour

Milled Ground Starch – primarily wheat but other seeds can be used (e.g. rice, potato, corn…) Varieties:

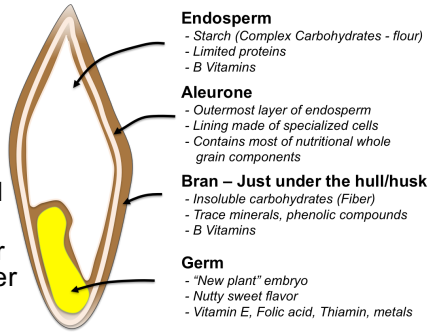
- Soft wheat – breads and batters
- Hard wheat – bread dough using eggs and yeast
- Durum wheat – hardest with most gluten and used for pasta

Wheat Anatomy

Kernel – Endosperm, used to make white flour.

Germ – Embryo – where the sprout emerges, Filled with oil and nutrients.

Bran – Protective outer shell of the kernel. Fiber supplement



Hard or Soft Wheat

Hard wheat has *high protein* content – with gluten and is used in breads and quick bread

Soft wheat is *low protein* – used in cakes pastries and cookies

Table 10-1 Protein Content and Use of White, Wheat-Based Flours

Flour type	Protein (% of total)	Primary use in cooking
Cake	7.5-8.5%	Cakes, quick breads, muffins and pancakes. Produces a tender crumb.
Pastry	8-10%	Pie crusts and pastries.
Instant	9.5-11%	Sauces and gravies.
Bleached, all-purpose	9.5-12%	General use flour for all cooking and baking purposes, but contains a little too much protein for the best pie crusts, muffins, and pancakes and too little flour for the best yeast breads.
Bread Flour	11.5-12.5%	Yeast breads, pasta, pizza
Durum Wheat (Semolina)	13-13.5%	Pasta

White Flour

White Flour is made mostly of the kernel

- All-Purpose – used for many recipes and as a thickener(10-12% protein)
- Southern Brands – for biscuits and frying – (8% protein)
- Unbleached – Preferred for yeast requiring breads (bleach inhibits growth of microbes)
- Bread Flour – Higher protein content (12-14% high gluten content)
- Cake Flour – High protein 6-8%, low gluten content
- Seminola/Durum – high gluten from endosperm

Whole Wheat Flour – Ground bran and germ plus the kernel. More dense and will not rise as well (poor gluten formation).

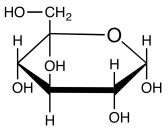
Wheat Flour

Starches – complex carbohydrates (70%)

Fats – low amounts (germ)

Proteins – several proteins including glutenin and gliadin (make up gluten)

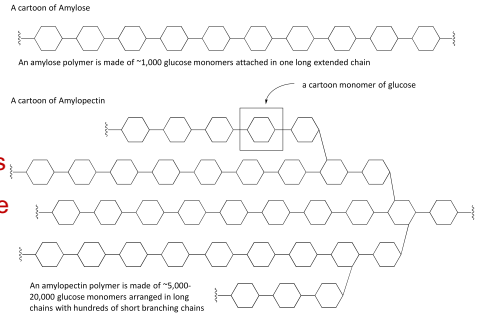
Starches of Flour



Glucose

Starch makes most (~98-99%) of wheat component

- 1-20% amylose
- 80-90% amylopectin
- Amylose efficiently packs into strands coils and tightly binds protein – protecting proteins from enzyme degradation
- Amylopectin – forms large tangles and poorly binds proteins



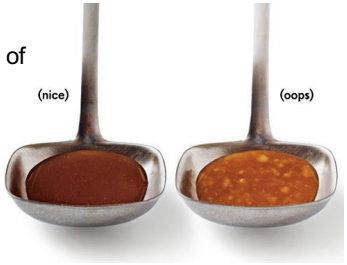
Lumpy Gravy

Lumps are tightly packed structures of starch and protein with water tightly bound to surface proteins and some of the carbohydrates

Water is unable to penetrate the interior starches

- Low protein flour will decrease chance of protein forming a water-gel shell
- Dissolve some of the flour in warm water while mixing to avoid forming of clumps and encouraging (warmth) swelling of the starch with water

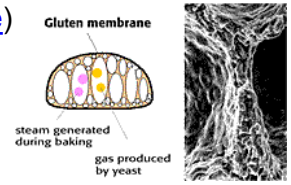
At about 120oF/49oC starches absorb enough water to form a gel (semi-solid mass) as the water and starches form interconnections and amylopectin unpacks to form larger tangles



What is Gluten?

Gluten – a combination of two proteins which can stretch to form long elastic strands and gives dough plastic (ability to rebound it's shape and keep a shape under pressure).

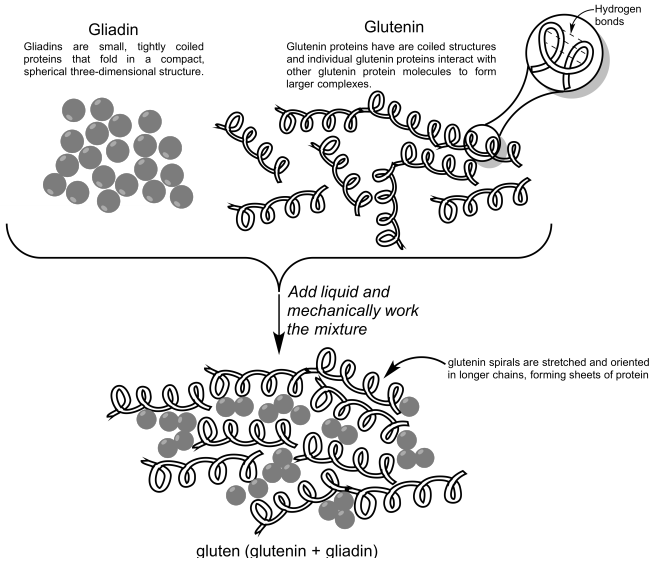
- Helps to keep bubbles of gas in breads and other dough (slice-o-scope)
- Called the muscle of flour



Gluten – a tale of two proteins

Glutenin – Long and very large proteins which have lots of sulfur atoms. Coiled proteins which can stretch and recoil. Sulfur (cystine side chains) help hold these together

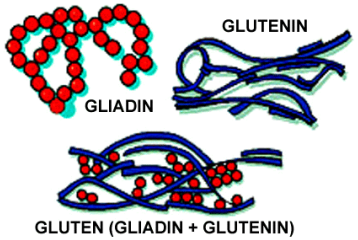
Gliadins – Smaller proteins which act like lubricants or ball bearings – allowing parts of glutenins to move past each other



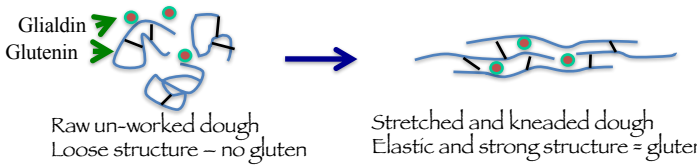
Gluten Formation

Stretching of dough pulls the glutenin into long strands which pulls back when relaxed.

Kneading unfolds and aligns the proteins into strands



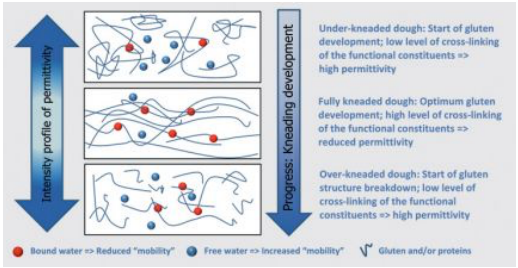
Dough Strength = Gluten Formation



Coils and sulfur cross-links (black lines) of glutenin give the elastic ability to dough

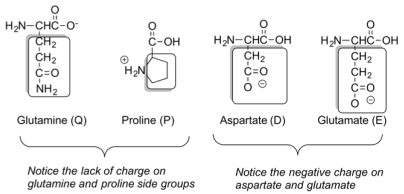
- High protein (and gluten) flour give strong gas pockets good for breads
- Low gluten flours are weaker tender baked goods – cakes and cookies (that is why you don't over mix pancake mix)
- High water dough (called batter) dilutes gluten so they don't mix/bind - Click here to explore Gluten

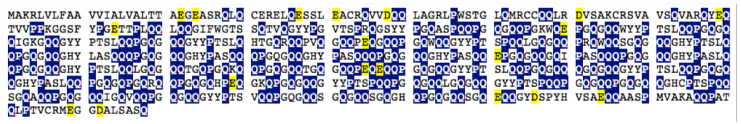
How tough is your dough?



Stirring and kneading water/flour or dough will stretch out and make the gliadin and glutenin interact. The more the flour is worked, the more interactions and alignment. Kneading is done to achieve this result. Too much and you can break your dough!

Amino Acids Give Function





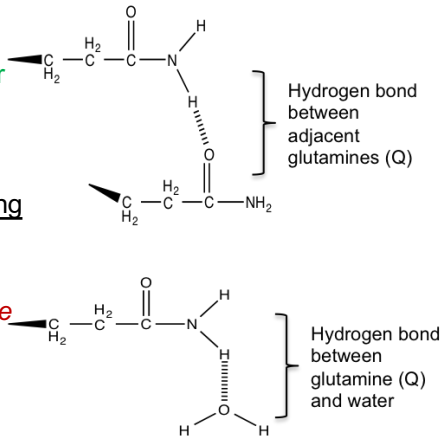
The protein sequence in single letter amino acid abbreviations for glutenin. Notice the **high** proportion of Q & P (highlighted in dark shading) and the **low** abundance of charged D & E (Shaded in light color)

Why so many Glutamines?

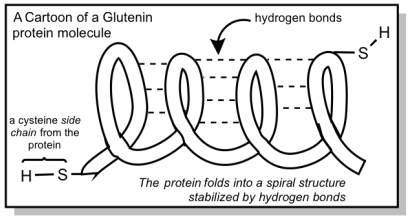
Glutamine supplies N for growing seedling.

ALSO Glutamine side chains (amine) can hydrogen bond with another glutamine forming a crosslink between strands of glutenin

- *If there were less glutamines, the amine would bind to water instead reducing cross-linked strength*



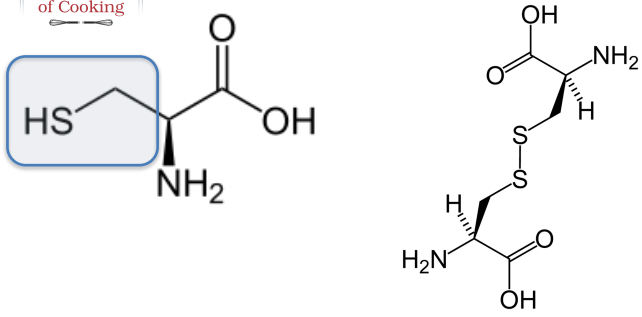
Proline



Up to 50% of amino acids of glutenin can be proline – typical protein is ten to 20 times lower

- Prolines are the most inflexible amino acids and in a peptide / protein backbone lead to bends and kinks breaking up helixes started by glutamine
- This gives glutenin its elasticity

What about Cysteines?



Two cysteine amino acids bond forming a disulfide – a cross-linked glutenin is more stable and mechanically rigid

Strengthen your flour muscle

Oxidizing agents – alter sulfur links and increases strengths of gluten

- Flowing oxygen gas through the flour "ages" it by allowing sulfur-sulfur links to form – giving more cross-links (stronger flour)
- Chlorine gas and brominates (can do same thing) but no longer approved
- Ascorbic acid (vitamin C) is now used instead of gasses.
- Also causes the flour to whiten (bleaching)

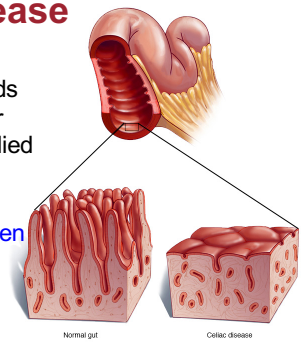
Changing the strength of your dough

Change Protein content– total protein content in flour will adjust the total gluten content (bread flour 13% protein; cake flour ~8%)
Stirring and kneading – release the sulfur ends of glutenin and organize the protein into long strands – more elastic/strong
Salt – increases the gluten network by decreasing the charged repulsions between proteins
Sugar – added sugars limit gluten development
Fats and Oils – weaken bonds between glutenin strands
Acidity – create more of the same charge (negative) amino acids on glutenin which will then repulse each other – weaker breads like sourdough (made sour by lactic acid producing bacteria)

Gluten Intolerance Celiac Disease

Physician found patients in the Netherlands suffering from "Coeliac" disease got better during occupation but got sick when supplied with their food – missing link? Bread and wheat.

- Autoimmune disease triggered by gluten and attacks the villi of the gut
- Poor digestion and resulting nutrition
- Genetic disease – protein in blood is detected when exposed to gluten



Gluten Intolerance is not the same. Several studies indicate most who report gluten problems may not be real (Is it in your head?) It might be small polysaccharides or other sugars poorly digested. Impacts people with irritable bowel syndrome but not the same as CD

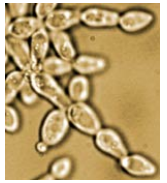
Raising the dough

Yeast and Leavening

Where do the gas bubbles to make the dough rise come from?

Fermentation (yeast) and CO_2 (leavening agents)

Yeast



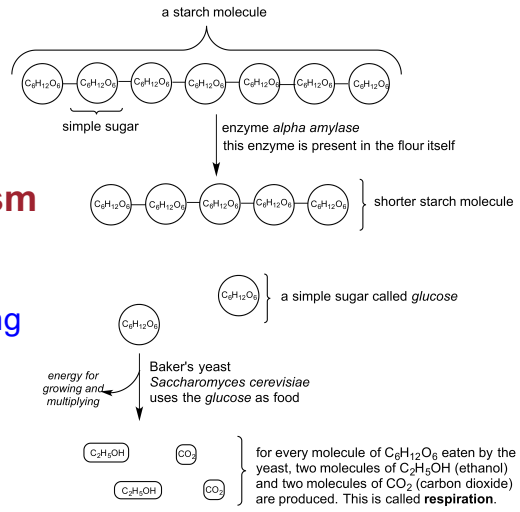
Baker's Yeast – *Saccharomyces cerevisiae*

- Single cell fungus – over 160 species of yeast
- Yeast use sugar to metabolize that food for energy: Glucose is converted to alcohol and carbon dioxide
- Baking expands the CO_2 gas and burns off the alcohol

$$C_6H_{12}O_6 + O_2 \rightleftharpoons C_2H_5OH + CO_2 + \text{energy}$$

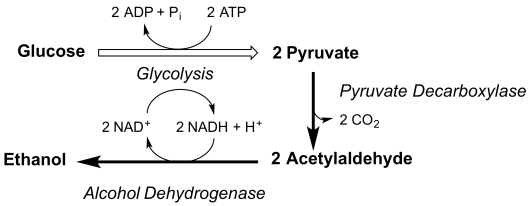
Sugar — Oxygen — Ethyl alcohol — Carbon dioxide

Yeast Metabolism



Process of metabolizing glucose is called… glycolysis

Ethanol Production in Yeast



Continued respiration (glucose metabolism to pyruvate and carbon dioxide) requires a regeneration of NAD+ from NADH. Yeast use alcohol dehydrogenase for this step. The byproduct (from the yeast's perspective) is ethanol.

Louis Pasteur (1859) discovered how yeast works:

- Yeast feeds on starches (sugars) in flour (metabolism/fermentation) to produce carbon dioxide
- The CO2 expands pushing the gluten proteins around in the flour
- Bubbles are trapped by gluten and the proteins become fixed as the bread is baked

Simple sugars (sucrose, fructose, glucose and maltose) are found in smaller amounts in unsweetened flour

- Since yeast need sugar to grow and produce gasses, this flour will give low rising breads
- Added sugar increases yeast activity
- YET – large amounts can decrease the yeast – sweet breads. So does salt!

Forms of Yeast

Cake or compressed yeast – live pressed blocks of yeast.

- Must be kept moist and cold
- Only lasts a few weeks
- Used by professional bakers and gives best results

Forms of Yeast

Active dry yeast – dormant, dried yeast.

- Granules of yeast with a coating from yeast culture
- Long shelf life (several months)
- To hydrate, must be soaked in 105-110°C water

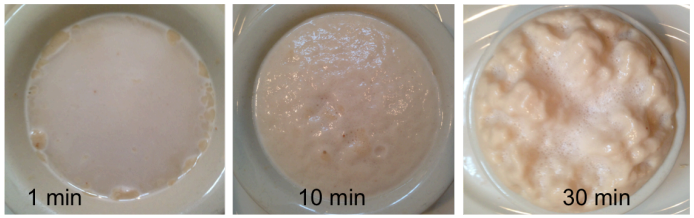
Forms of Yeast

Instant dry yeast – dormant, dried yeast.

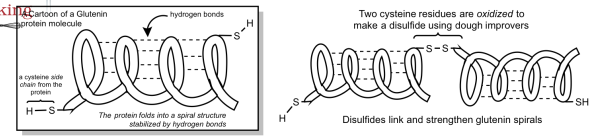
- Improved version of active dry yeast, less debris and healthier yeast
- Long shelf life (several months)
- No need to hydrate – can add as dry mix

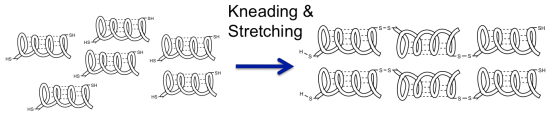
Proofing Yeast

Adding sugar or honey supports the "awakening" of the yeast. Ensures proper raising of the dough!



Kneading your Dough





Kneading stretches and compresses proteins over and over to strengthen the gluten network

- Aligns proteins on long strands
- Encourages links between strands
- Also creates pockets of air to expand when heated
- Low kneaded breads will result in large air pockets with less developed gluten

Preparing the Dough

Mixing – add all ingredients together

- Starch will swell when wet
- Enzymes from flour will digest some of the sugars reducing yeast growth
- Initial mixing of gluten draws proteins together but as air oxidizes sulfur ends, the glutens form end to end bonds creating long chains

Autolysis – mix water and flour first to let gluten and starch absorb water before adding rest of components

Kneading your Dough

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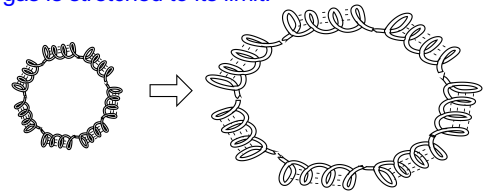
Raising your bread

- Bread will rise due to the trapped CO_2 gasses generated by yeast.
- Ethanol – will disperse and volatile during heating
- Heat is needed for yeast to grow – too cold and the yeast becomes dormant, to warm and the yeast will die.
- Best temp: 27oC/84oF
- “doubling” of the size of the dough is about where gluten trapping gas is stretched to its limit.



Baking Bread

Early Baking – Steam of water in bread or oven creates further expansion of gasses

- The dough rises from steam and heating of gluten-trapped gas bubbles
- Alcohol from yeast evaporates and brings small aromatic molecules with it some caramelization – the smell of baked bread!

PV = nRT
Gasses expand

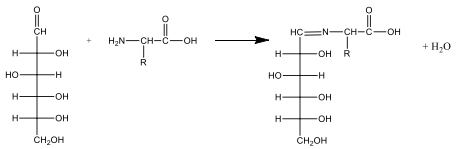
More gasses, and heat will make the dough AND the bread rise.

Baking Bread

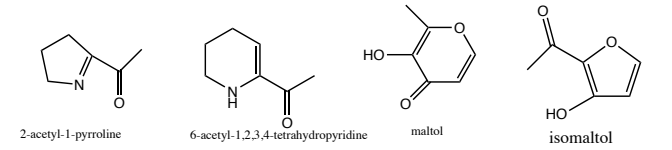
Late baking – as the temp approaches boiling point:

- the starch turns into a gel
- and the crust browns
- Finished bread will be fully set and detected by indirect tapping on the bottom of the loaf
- Uncooked bread will be wet with gluten gel and should sound heavy and dense
- Cooked bread will be an open sponge and sound hollow

Flavors and Smell of Baked Bread



Our friend the Malliard reaction provides the small volatile compounds you smell



Roasted Bread Crust | Cracker-like flavor | Caramel | Burned Caramellic

Special Breads

Sourdough Bread – Acid flavor which enhance gluten formation

- Acid comes from bacterial culture in dough
- Maintaining cultured dough with lactic acid producing bacteria and specific strains of yeast– can be used over and over
- Cultures are fed flour and water over time.
- Other forms of acid used are buttermilk or yogurt

Pancakes

More flour and thick batter than crepes or popovers (more fats and water)

- Folding batter with low water, a bit more salt and cooking slow create softer thicker pancakes (less gluten and bigger gas bubbles)
- High mixing, more water, higher heat (quick cooking time) and low salt will produce thinner but more dense pancakes

Leavening Agents

Dough with low gluten, runny batter and minimal mixing (biscuits, pancakes) do not have ability to hold gas bubbles for long

- Yeast production takes too long
- Quick breads – use a chemical means to produce gas in a short time

Most chemical leavening agents produce CO_2 gas bubbles from one source or another

Quick Breads – Chemical Rising

Early breads used potash (extract of wood ash) for it's potassium carbonate.

- When reacted with lactic acid produce carbon dioxide gas

Baking Soda– sodium bicarbonate

- When reacted in water with an acid will produce CO_2 gas

$$NaHCO_{3\,(s)} + H_{(aq)}{}^{+} \longrightarrow H_2O_{\,(l)} + CO_{2(g)} + Na^{+}$$

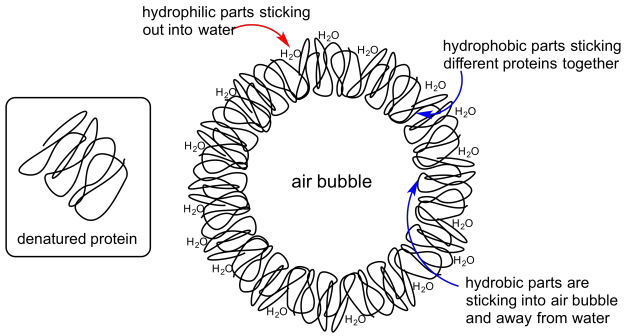
Baking Powders – dried forms of acids and bicarbonate

- Goal is to produce the gas when chemicals are dissolved in water or other liquid
- Mixed with starch to keep dry
- Acids vary from tartaric acid (cream of tartar) to phosphate acids (which take longer to produce acid and work when heated)

Double acting powders – create two sets of reactions – one set when wet, the other during baking

Most baking powders are double acting

Cakes – proteins (non gluten) trapping the gas



Cakes

Web of flour eggs sugar and fat (shortening) to produce mostly thin cages of protein around the gas bubbles.

- The more bubbles the more "light" the cake
- Sugar, butter or fat and low protein cake flour (about half of all purpose flour) create poorly connected and low amounts of gluten.
- Too much inhibition of gluten will collapse the cages around the bubbles and a thick cake results

Cake Secrets!

Cake shortening – hydrogenated vegetable oil with nitrogen gas bubbles works at room temp to mix will. N2 gas provides additional bubbles.

Cake flour –

- Fine milled low protein/high starch – smooth texture
- Chlorine gas treatment (now oxidized with other chemicals) helps to swell starch and bind fat to limit gluten formation

Making a Cake

Mixing is critical – introduces bubbles to expand during heating

- Different methods of aerating – see book
- Flour is often added only after a foam is created to limit the strengthening of gluten

Three stages of baking

- Batter expands (based on aerating and leavening)
- Then egg proteins denature to form protein cages around bubbles and starch swells
- Final stage solidifies protein/starch and browns proteins for final flavor

Generation of the Foam

Creaming the butter – critical step to incorporate air into cake mix.

- “cream butter and sugar together until light and fluffy”
- Key source of gas bubbles
- Mixes sugars to support protein cages around the gas
- Eggs develop the foam and provide moisture
- Whipping organizes hydrophobic / hydrophilic interface around air bubble