Chapter 7
Gluten

How Baking Works

Words, Phrases, and Concepts

- Glutenin
- Gliadin
- Tenacity
- Elasticity
- Extensibility
- Windowpane
- Bucky dough
- Slack dough
- Mechanical dough development
- Chemical dough development
- Water hardness
- pH
- Letdown stage
- Reducing agent
- Glutathione
- Protease
- Dough relaxation

Introduction

Gluten:

- One of three main structure builders in baked goods.
  - Egg proteins and starch are other two.
  - Especially important with yeast doughs.
- Affected by formula and method of preparation.

Gluten Formation and Development

Gluten:

- Is a large, complex protein.
  - Made up of glutenin and gliadin, two proteins in flour.
- Forms a strong, stretchy network when flour is mixed with water.
  - Glutenin: provides strength and elasticity.
    - Strength is also called tenacity; a measure of how much force is needed to stretch dough.
    - Elasticity refers to the ability to bounce back once dough is stretched.
  - Gliadin: provides extensibility, or stretchiness.

Gluten Formation and Development

Yeast doughs need a balance of glutenin and gliadin:

–Need a balance of strength and stretchiness.

Gluten Formation and Development

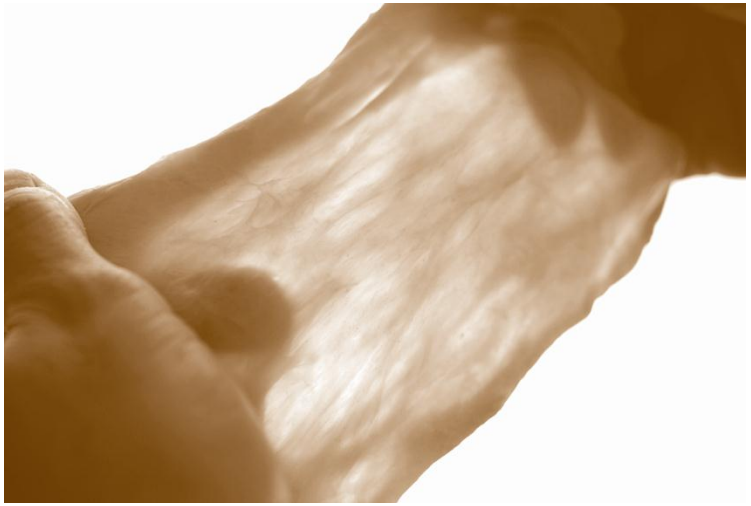
Gluten:

- Changes as it is handled.
- Dough becomes smoother, stronger, drier, and less lumpy as gluten develops.

Gluten Formation and Development

When yeast dough reaches a balance of strength and stretchiness:

- Has reached dough maturity.
- Can be stretched into a paper-thin sheet of dough known as a windowpane.



Determining Gluten Requirements

Baked goods vary in their need for gluten.

- Yeast doughs need gluten for fermentation tolerance:
  - For the ability of dough to hold in gases generated from yeast fermentation.
  - Important throughout proofing and oven spring.
    - Provides for large loaf volume and fine crumb.
    - Ciabatta dough requires less gluten than sandwich bread (pain de mie).

Determining Gluten Requirements

Baked goods vary in their need for gluten.

- Cakes and most other pastries need less gluten than yeast doughs.
  - Many rely more on other structure builders (eggs and starch).
  - However, gluten often needed to prevent crumbling, collapsing, or slumping.
    - *Examples*: pie crust, baking powder biscuits.

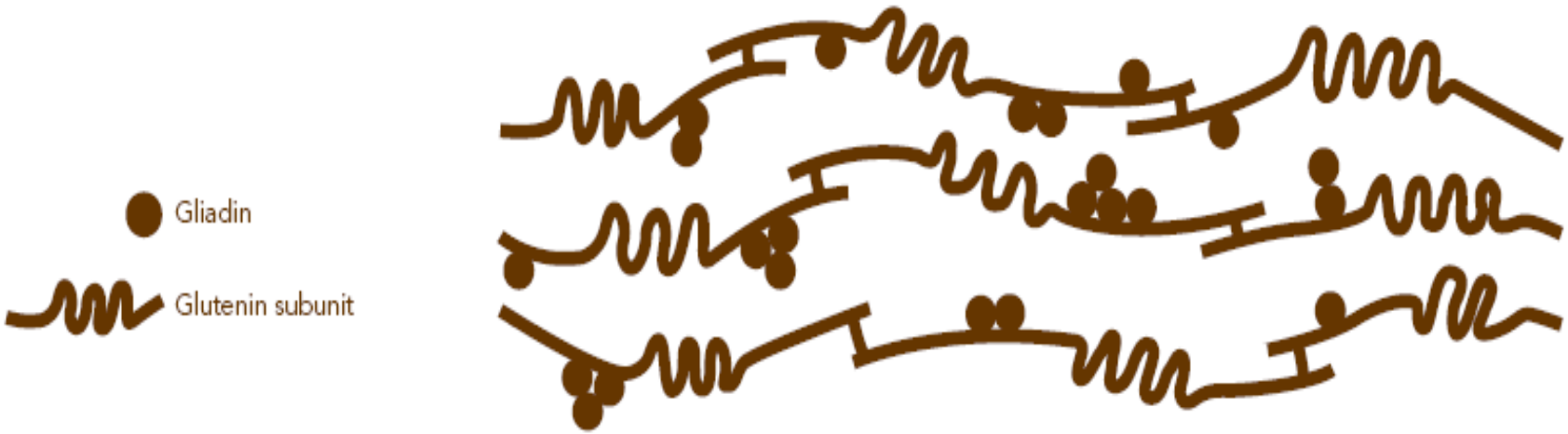
Controlling Gluten Development

- Three ways that gluten develops and matures in yeast dough:
  - Mechanical dough development: mixing.
  - Chemical dough development: addition of maturing agents that strengthen.
  - Bulk fermentation and proofing.
    - Complex; many changes besides gluten development occur simultaneously.
- Each acts differently, but all encourage gluten development.

Gluten Formation and Development

Gluten development:

Results from the alignment and bonding of glutenin into a large, cohesive gluten network.



Controlling Gluten Development

- Many ways to control gluten development:
  - Know how to increase gluten so that:
    - Dough is stronger and more elastic, or
    - Baked good is firmer and holds it shape.
  - Know how to decrease gluten so that:
    - Dough is softer, slacker, and more extensible, or
    - Baked good is more tender.
- Not all techniques work in all products:

  Examples: dough conditioners, heat-treated milk.

Controlling Gluten Development

1. Type of flour
   - Type of grain.
     - Wheat, rye, oat, corn, etc.
       - Wheat is only grain with significant glutenin and gliadin.
   - Varieties of wheat.
     - Soft, hard, durum.
   - White vs. whole wheat.

Controlling Gluten Development

2. Amount of water
   - When gluten is not fully hydrated, additional water increases gluten development.

     Examples: pie and biscuit doughs.
   - When gluten is fully hydrated, additional water dilutes and decreases gluten development.

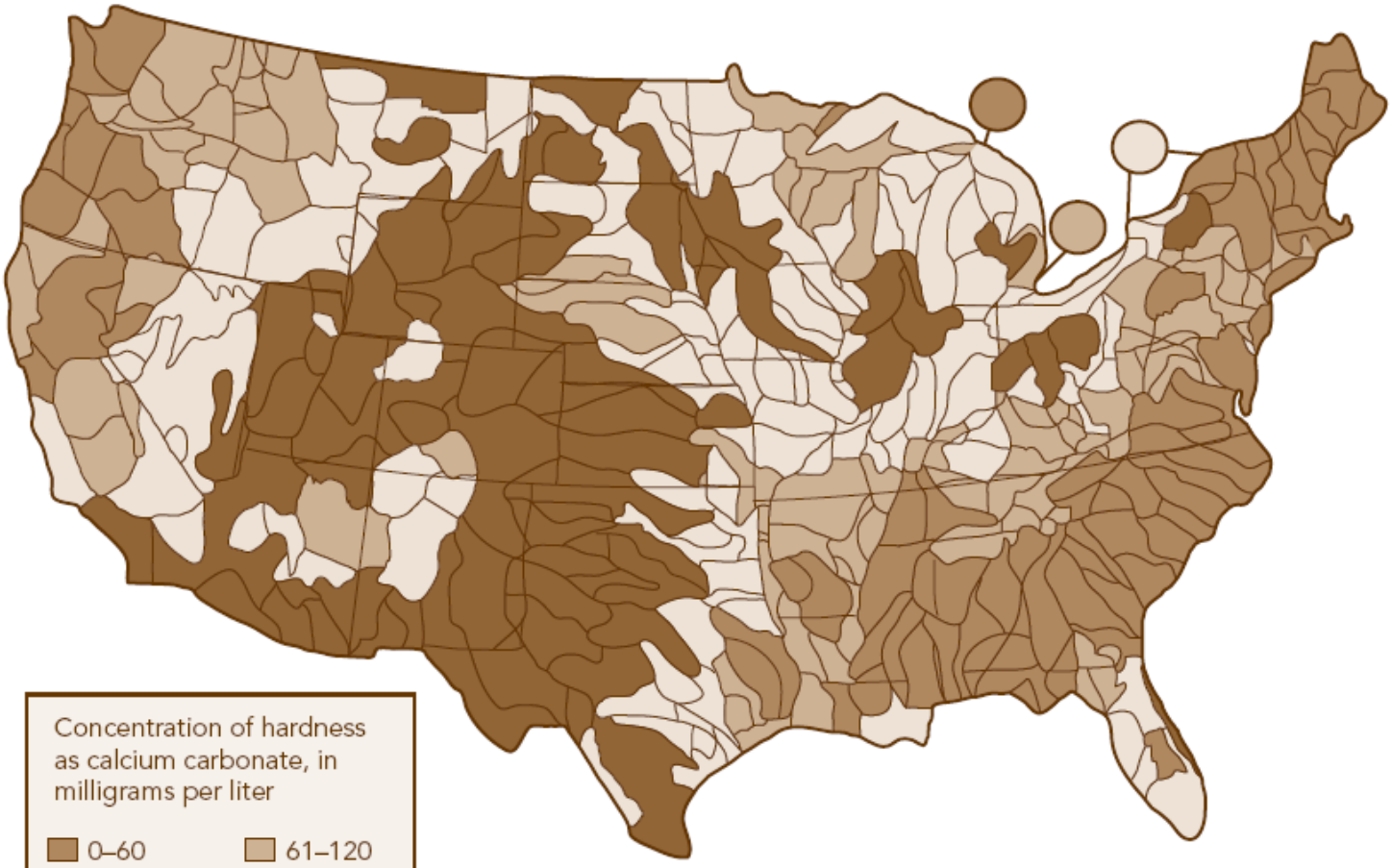
     Examples: cake batter, well-hydrated bread dough.

Controlling Gluten Development

3. Water hardness
   - Measure of mineral content: calcium and magnesium.
     - Hard water is high in minerals; produces strong, bucky dough.
     - Soft water is low in minerals; produces soft, slack extensible dough.
   - In yeast doughs, usually best to have water that is neither too hard nor too soft, so that strength and extensibility are in balance.

Controlling Gluten Development

Water hardness varies across the country.



Courtesy of the U.S. Geological Survey

Controlling Gluten Development

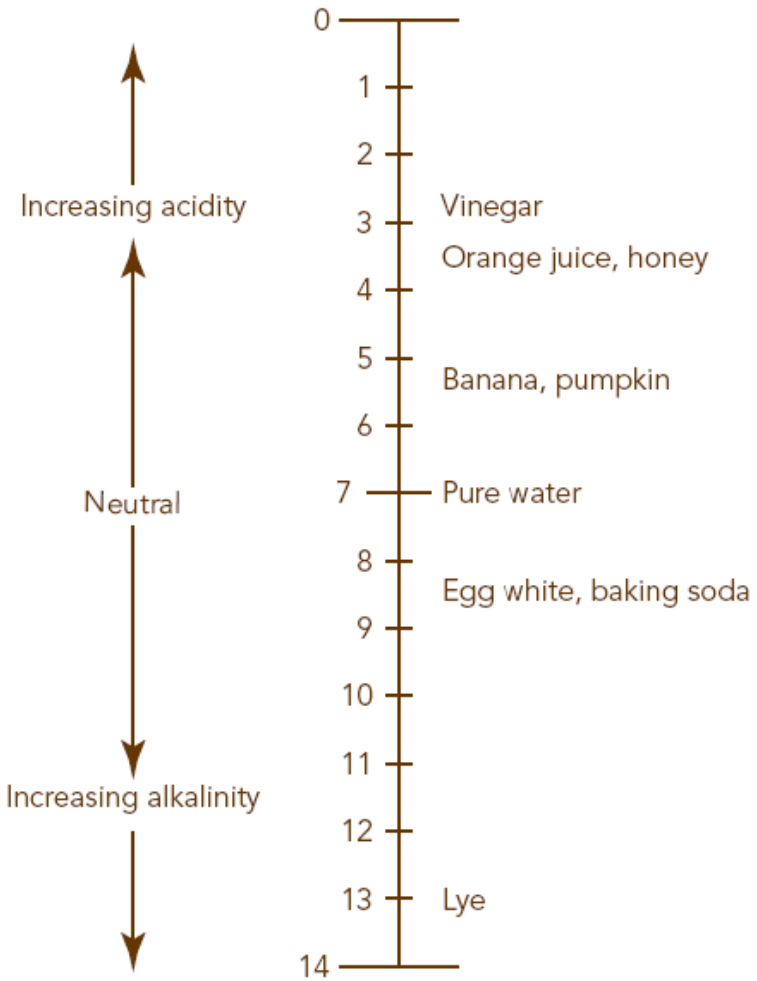
4. Water pH

- Measure of acidity or alkalinity.
- For maximum gluten:

  pH = 5-6 (slightly acidic).
- Adding acid lowers pH.

  Example: Vinegar makes strudel dough softer, more extensible.
- Adding alkali (base) raises pH.

  Example: Baking soda makes cookies thinner, more open, more tender.



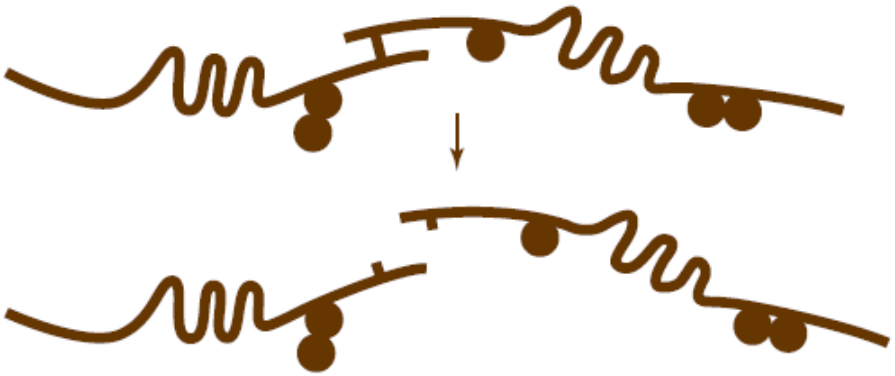
Controlling Gluten Development

5. Mixing and kneading
   - The more mixing, the more gluten development – up to a point.
   - Mixing increases gluten development as it:
     - Speeds up hydration of flour particles.
     - Adds oxygen from air into dough.
     - Distributes particles evenly throughout dough.

Controlling Gluten Development

5. Mixing and kneading (cont.)
   - Lengthy or vigorous mixing breaks down gluten structure.
     - Letdown stage of mixing yeast doughs.
     - Dough becomes soft, sticky, easily torn.
     - The weaker the gluten, the more easily it overmixes.

       Examples: rye dough; rich, sweet yeast doughs.



Controlling Gluten Development

6. Batter/dough temperature
   - Warmer the temperature, the faster gluten develops.
     - Not a common means of controlling gluten development.

       Examples: yeast-raised dough; pie pastry dough

Controlling Gluten Development

7. Maturing agents and dough conditioners
   - Maturing agent that weakens gluten: chlorine.
   - Maturing agent that strengthens: ascorbic acid.
   - Dough conditioners:
     - Multifunctional ingredients.
     - Primarily, they strengthen gluten.

Controlling Gluten Development

8. Fermentation and proofing
   - Expanding air bubbles push on gluten, strengthening it.
   - Additional fermentation and proofing can weaken gluten.
     - Dough becomes softer and more extensible.
   - Overall, complex effect on gluten: many chemical and physical changes happening.

Controlling Gluten Development

9. Reducing agents
   - Opposite of maturing agents that strengthen.
   - Weaken gluten; doughs become softer, more extensible.
   - Example: glutathione
     - Found in: fluid milk, active dry yeast, wheat germ.

Controlling Gluten Development

10. Enzyme activity
    - Proteases are enzymes that break down proteins, including gluten.
    - Weakens gluten; dough becomes softer, more extensible.

Controlling Gluten Development

10.Enzyme activity (cont')

TABLE 7.1 SOURCES OF PROTEASE ACTIVITY IN BREAD BAKING

Malted flours, including malted barley flour (dry malt)
Sprouted wheat berries
Soakers
Whole wheat flour
Rye flour
Autolysed doughs
Liquid levains (sourdoughs)
Poolish and other pre-ferments

Controlling Gluten Development

11. Tenderizers and softeners
    - Interfere with or limit gluten development.
    - *Examples*:
        - Fats, oils, and emulsifiers.
            - Shortening is named for the ability of fats to “shorten” gluten strands.
        - Sugars.
        - Leavening gases.
            - Gluten strands stretch thin as leavening gases expand, weakening cell walls.

Controlling Gluten Development

12. Salt
    - Strengthens gluten and makes it less sticky.
        - Prevents excessive tearing as gluten stretches.
        - Salt is sometimes added late in the mixing of yeast doughs.
            - Reduces frictional heat from mixing.

Controlling Gluten Development

13. Other structure builders
    - Interfere with gluten development, even as they contribute their own structure.

      Example: starches, especially if ungelatinized; eggs in rich sweet yeast doughs.

Controlling Gluten Development

14. Milk
    - Fluid milk:
        - Source of water; increases gluten development.
        - Contains glutathione; reduces gluten during fermentation and proofing.
            - Dough becomes softer, more extensible.
            - Scalding milk first inactivates glutathione.
    - Dry milk solids (DMS):
        - Low-heat DMS: contains glutathione; weakens gluten.
        - High-heat DMA: contains no glutathione; does not weaken gluten.

Controlling Gluten Development

15. Fiber, bran, grain particles, fruit pieces, spices, etc.
    - Weaken gluten by shortening gluten strands.
      - Particles physically interfere with gluten strands from forming.

Controlling Gluten Development

Dough relaxation

- Dough resting period.
  - Bench rest for yeast doughs.
  - Refrigeration of laminated doughs between folds.
    - Refrigeration also solidifies fat, for more flakiness.
- Makes it easier to shape, roll and fold dough properly.
  - Dough is less elastic and more extensible.
- Dough shrinks less during baking.