Chapter 3
Overview of the Baking Process

How Baking Works

Words, Phrases, and Concepts

- Structure builder
- Toughener
- Tenderizer
- Moistener
- Drier
- Air bubbles
- Foams and sponges
- Hydration
- Gluten
- Batters and doughs
- Oven spring
- Starch granules
- Starch gelatinization
- Maillard browning
- Amylase
- Retrogradation

Introduction

Three stages in baking process:

I. Mixing
II. Baking
III. Cooling

Introduction

Success in the bakeshop starts with a properly-balanced formula that contains a balance of:

- Toughеners and tenderizers.
- Moisteners and driers.

Introduction

Structure builder

- Also called toughener.
- *Examples*: flour, eggs, cocoa powder, cornstarch.
  - The proteins and starches in flour, eggs, and cocoa powder are the actual structure builders.
- Holds the volume and shape of baked goods in place.
- Too much structure results in tough, hard baked goods.

Introduction

Tenderizer

- Interferes with the formation of structure.
- *Examples*: sugars and syrups, fats and oils, leavening agents
- Softens baked goods, making them easier to bite into.
- Too much tenderizing leads to crumbling or collapse.

Introduction

Moistener

– Thins out batters and doughs.

– *Examples*:

- Water (moisture) and ingredients that contain water, including milk, eggs, cream, and syrups.
- Oil and melted fat.

Introduction

Drier

– Opposite of moistener.

– An ingredient that absorbs moisteners.

Examples: flour, cornstarch, dry milk solids, cocoa powder.

Stage I: Mixing

- Mixing method is important
  - *Example*: muffins mixed using muffin method compared with creaming method
- Ingredient temperature is important
  - *Example*: pie pastry dough mixed with cold vs. warm ingredients

Stage I: Mixing

As batters and doughs are mixed:

- Ingredients are distributed evenly throughout.
- Air bubbles are mixed in and reduced in size.
  - Lightens batter/dough.
  - Provides for proper leavening and crumb formation.

note: batters/doughs are considered *foams* because air bubbles are trapped.

Stage I: Mixing

As batters and doughs are mixed (cont.):

- Large solid particles are worn down, layer by layer, into smaller ones.
  - Allows them to dissolve or to hydrate faster.
- Fats/oils break into small chunks or droplets.

Stage I: Mixing

Role of water in mixing:

- Dissolves small molecules.
  - Activates them.
  - *Examples*: sugar crystals, baking powder.
- Hydrates large molecules and particles.
  - Hydration: layers of water surround large molecules (driers), swelling and suspending them.
  - Activates them.
  - *Example*: formation of gluten.

Stage I: Mixing

Role of water in mixing (cont.):

- Hydrates and activates yeast.
- Adjusts batter/dough temperature.

  Example: bread dough.
- Adjusts batter/dough consistency.
  - *Batters* are high in moisture; thin and pourable.
  - *Doughs* are low in moisture; thick and moldable.

Stage I: Mixing

Many ingredients are significant sources of water in the bakeshop.

TABLE 3.2 AMOUNT OF WATER IN VARIOUS BAKESHOP INGREDIENTS

INGREDIENT	AMOUNT OF WATER (%)
Strawberries	92
Lemon juice	91
Orange juice	88
Milk, whole	88
Eggs, whole	75
Banana	74
Sour cream	71
Cream cheese	54
Jellies and jams	30
Butter	18
Honey	17
Raisins	15

Stage II: Baking

- During baking:
  - Heat is slowly conducted from the outside in.
  - Heat transforms batter/dough from a foam that traps air bubbles to a porous sponge that does not.
    - Term *sponge* is used whether product has a springy, spongy texture or not.

Stage II: Baking

Crumb, or grain, of baked goods consists of air cells surrounded by porous cell walls.

Stage II: Baking

Baking involves at least eleven events.

- Is complex.
- Events occur concurrently and influence each other.
- Many would never occur at room temperature; this is, heat is required.
- Several have no upper limit; that is, they continue for as long as baked good is in oven.

  Examples: protein coagulation, starch gelatinization, evaporation of gases.

Stage II: Baking

1. Fats Melt.
   - Most melt between 90º and 130ºF (30º–55ºC).
   - Results in:
     - Increased volume, or rise: trapped steam and air expand.
       - The later fats melt, the more rise.
     - Increased tenderness: melted fats coat structure builders.
       - The sooner fats melt, often the more tenderness.

       Example: oil and pie pastry dough.
     - Thinned batters and doughs.

       Example: high-fat cookie dough and spread.

Stage II: Baking

2. Gases Form and Expand.
   - Starts at room temperature; continues until about 170ºF (75ºC).
   - Three most important leavening gases: air, steam, carbon dioxide.
   - Results in:
     - Increased volume or rise: expanding gases push on cell walls.

       Example: Oven spring
     - Increased tenderness: expanding gases thin cells walls, making them easier to bite.

Stage II: Baking

3. Microorganisms Die.
   - Microorganisms include: yeast, mold, bacteria, viruses.
   - Most die at 135 –140ºF (55–60ºC).
     - Depends on microorganism and amount of sugar or salt.
   - Results in:
     - Fermentation stopping.
     - Safer food, since pathogenic bacteria are killed.

       Examples of pathogens: Salmonella bacteria, hepatitis virus.

Stage II: Baking

4. Sugar Dissolves.
   - Heat of oven dissolves sugar that did not dissolve during mixing.
   - Results in:
     - Moistening, tenderizing, browning, sweetening.
       - That is, sugar now acts like sugar.
     - Thinned batters and doughs.
       - Dissolved sugar pulls water from driers.

   Note: other solutes that dissolve during baking include acid salts in baking powder

Stage II: Baking

5. Egg and Gluten Proteins Coagulate.
   - Starts at 140 –160ºF (60–70ºC).
   - Egg proteins:
     - Unfold (denature) and bond, forming a network of stretched-out clusters of egg proteins.
     - Heat dries out and stiffens the proteins.
   - Results in formation of rigid structure that sets the final size and shape of baked goods.

Stage II: Baking

6. Starches Gelatinize.
   - Starts at 120 –140ºF (50–60ºC).
   - Starch granules, tightly-packed with starch molecules, swell and soften.
   - Results in:
     - Thickening of batter/dough.
     - Formation of rigid structure that sets the final size and shape of baked goods.
   - Besides heat, water is required.
     - Bread dough vs. cookie dough

Stage II: Baking

7. Gases Evaporate.
    - Starts at about 160ºF (72ºC).
    - Rigid cell walls rupture from pressure of expanding gases; gases escape.
    - Results in:
        - Formation of dry, hard (white) crust.
        - Weight loss.
        - Aroma loss.

Stage II: Baking

8. Caramelization and Maillard Browning Occur on Crust.
   - Begins at 300ºF (150ºC) and above.
     - Temperature of crust rises only after water evaporation slows.
   - Caramelization: breakdown of sugars.
   - Maillard browning: breakdown of sugars and proteins together.
   - Results in:
     - Brown color.
     - Baked flavors.

Stage II: Baking

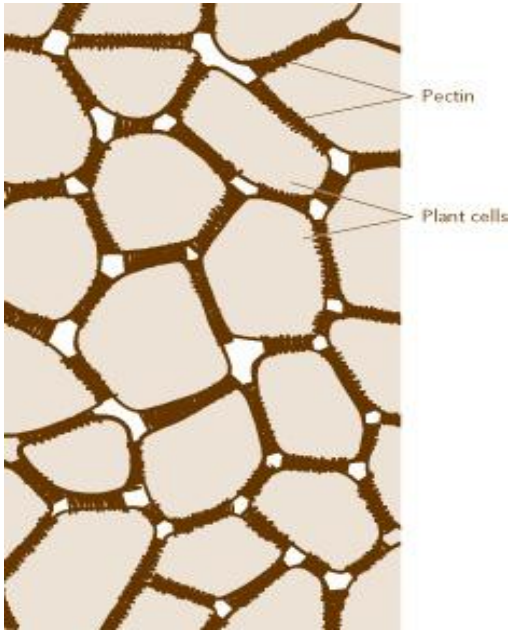
9. Enzymes are Inactivated.
   - By about 160 –180ºF (70–80ºC).
     - Below this temperature, rising oven temperatures increase enzyme activity.
   - Enzymes are:
     - Proteins.
     - Biological catalysts; that is, they speed up chemical reactions.
     - Denatured by heat.
   - Example: amylase.

Stage II: Baking

10. Changes Occur to Nutrients.
    - Examples of nutrients: proteins, fats, carbohydrates, vitamins, minerals.
    - Results in:
        - Proteins and starches becoming more digestible.
        - Destruction of certain vitamins (Vitamin C and thiamin).

Stage II: Baking

11. Pectin Breaks Down.
    - Pectin holds fruits together.



    - Dissolves when heated.
    - Results in softened fruit.

Stage III: Cooling

- Carryover cooking continues until baked goods reach room temperature.
- Changes occur during cooling and continue during storage.
  - Changes occur even when baked good is properly wrapped.
- Many changes result in firming of baked goods as they cool.
  - Best to cool products to 100ºF (38ºC) or below before slicing.

Stage III: Cooling

Eight main changes:

1. Gases contract; weak structure collapses.
   - *Example*: soufflés
2. Fats resolidify.
   - Decrease in greasiness, but product could become hard and waxy.
3. Sugars recrystallize.
   - Provides crunchy crust in low-moisture products.
4. Starch molecules bond and solidify.
   - Called retrogradation; major cause of staling.

Stage III: Cooling

Eight main changes (cont.):

5. Proteins bond and solidify.
   - Contributes to staling.
6. Moisture is redistributed within crumb.
7. Moisture moves from moist crumb to dry crust.
   - Crust loses crispness; can become tough and rubbery.
8. Flavors evaporate or become trapped by starches.
   - Brief reheating in oven recovers some lost flavor.