Chapter 12
Thickening and Gelling Agents

How Baking Works

Words, Phrases, and Concepts

- Polysaccharides
- Thickening
- Gelling
- Type A gelatin
- Sheet or leaf gelatin
- Bloom rating
- To bloom gelatin
- Vegetable gum
- Amylose
- Amylopectin
- Starch granule
- Cereal starch
- Root starch
- Modified food starch
- Instant starch
- Gelatinization
- Starch retrogradation

Introduction

To thicken or gel a food product:

- Add an ingredient that is already thick.
  - Sour cream, cream cheese, jams and jellies, syrups, fruit purees.
  - Besides thickening, these ingredients add color, flavor, and nutrients.
- Add an ingredient used exclusively for thickening and gelling.
  - Gelatin.
  - Vegetable gums.
  - Starches.
- Form an emulsion. *Example*: heavy cream.
- Form a foam. *Example*: whipped cream.
- Add eggs.

Thickening and Gelling

Thickening *Gelling*

Thickening occurs when water and other molecules or particles move around slowly.

Example: Pectin or other large molecules bump and loosely tangle.

Gelling occurs when water and other molecules or particles are prevented from moving around at all.

Example: Pectin or other large molecules bond or tightly entangle.

Thickening and Gelling

Almost any large molecule can thicken.

- Polysaccharides are very large molecules
  - Made of many (*poly*) sugar molecules (*saccharides*) linked together.

  Examples: Starch, vegetable gums.
- Proteins are very large molecules
  - Made of many amino acids linked together.

  Example: Gelatin.
- Many, but not all, molecules that thicken will gel when used at a high enough level.
  - Cornstarch thickens at low levels, gels at high levels.
  - Guar gum thickens at low levels, becomes gummy but does not gel at high levels.

Gelatin

Gelatin

- Forms an appealing crystal clear gel.

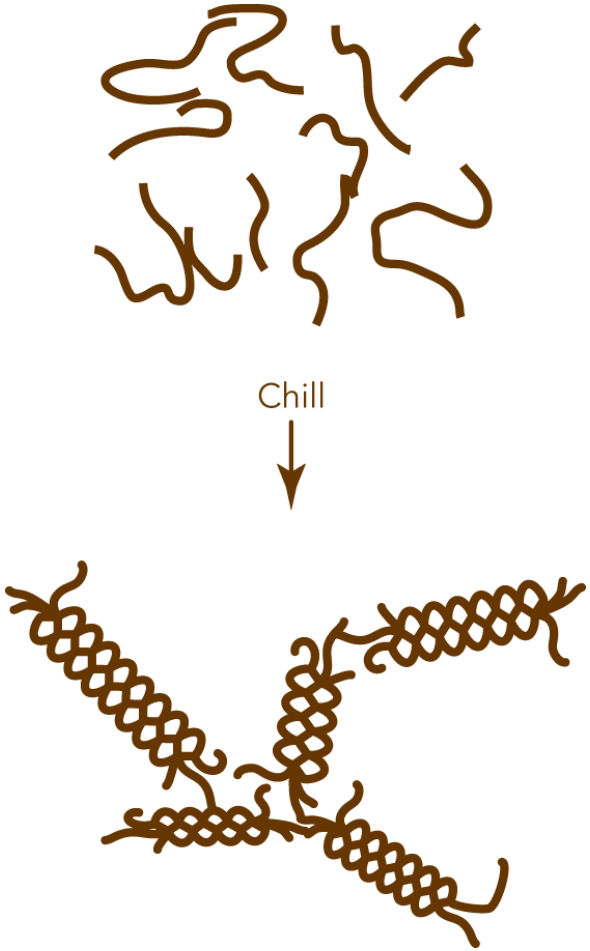
  Caution: gelatin forms lumps if not properly tempered into cold mixtures.

- Melts quickly and cleanly in mouth.

  Caution: gelatin forms tough, rubbery gels if used at too high a level.

- Is an animal protein.
  - Not allowed in strict vegetarian diets.
  - Sources of gelatin:
    - Pigskin (Type A gelatin).
    - Cattle bones and hides (Type B gelatin).
    - Fish (isinglass).
  - Type A gelatin, from pigskin, is by far the most common; not allowed in kosher (Jewish) or halal (Islamic) diets.

Gelatin



Gelatin gels as it cools.

- Tiny strands slow, coil up, tangle, and stack up into fragile junctions.
- Water gets trapped within this three-dimensional web.
- Fragile gel is easily dissolved with body heat.

Gelatin

Gelatin (Type A) is produced in a series of steps.

1. Chopped cleaned pigskins are soaked in cold acid.
    - Breaks down connective tissue: Rigid, ropelike collagen protein fibers are transformed into smaller invisible strands of gelatin.
2. Hot water is used for dissolving gelatin and extracting it from pigskins.
    - Process is repeated up to six times.
    - Each extraction occurs at a progressively higher temperature.
    - As extraction temperature increases, quality of gelatin goes down.
    - Gelatin solution is purified, concentrated, and formed into sheets or noodles.
3. Sheets or noodles are dried and ground into powder.

Gelatin

Sheet gelatin:

- Is also called leaf gelatin.
- Is made by further processing powdered gelatin.
  - Powdered gelatin is redissolved then cast into a thin film.
- As with powdered gelatin, sheet gelatin is available in different grades, or Bloom ratings.

Bloom rating is a measure of gel strength.

- Most gelatin ranges from about 50 to 300 on the Bloom scale.
- The higher the Bloom rating, the firmer the gel and the faster it sets. Also,
  - The lighter, clearer it appears and the milder it tastes.
  - The shorter, less stringy the gel.

Gelatin

Bloom rating

- Of common powdered gelatin is about 230.
- Of sheet gelatin is often designated by the name of a precious metal.
  - Silver and bronze sheet gelatin are most common types in North America.

TABLE 12.1 DIFFERENT GRADES OF SHEET GELATIN

GELATIN	APPROXIMATE BLOOM RATING	AVERAGE WEIGHT PER SHEET
Platinum	250	0.06 ounces (1.7 grams)
Gold	200	0.07 ounces (2.0 grams)
Silver	160	0.09 ounces (2.5 grams)
Bronze	140	0.12 ounces (3.3 grams)

Notice the weight of the sheet changes with the Bloom rating. If a formula calls for ten sheets, use ten sheets, no matter the Bloom rating.

Gelatin

How to Use

1. Bloom gelatin first, so it is less likely to clump.
   - To bloom gelatin means to add it to a cold liquid to hydrate.
   - Use almost any cold liquid; water is most common.

     Caution: Raw pineapple and kiwi juice contain an enzyme, a protease, that breaks down and liquefies gelatin.

     Caution: Liquids high in acid, like lemon juice, can weaken gelatin, although they will not completely liquefy it.
   - Wait 5 to 10 minutes, for gelatin to fully absorb water.
2. Heat the bloomed gelatin gently, or add to hot liquid, to melt.

   Caution: Do not overheat, or gelatin could weaken.

Gelatin

Differences between powder and sheets

- Bloomed differently.
  - Sheets are typically added to excess water, then removed and gently squeezed.

    Example: Take care that water is room temperature or cooler, so sheets do not dissolve completely.
  - Powdered gelatin is typically added to a measured amount of cold water.
- Measured differently.
  - Sheets are typically counted.
    - Easy to do with small amounts.
    - With large amounts, easier to weigh.
  - Powder is weighed.

Gelatin

Switching between different grades of sheet gelatin

- When counted, make a one-for-one substitution.

  Example: If a formula calls for five gelatin sheets, use five sheets of any grade gelatin; manufacturer adjusts weight per sheet, to compensate for different gel strengths.

- When weighed, account for differences in Bloom ratings by adjusting weights.

  Example: Instead of 100 grams of bronze sheets, use 76 grams of silver sheets:

  100 grams ÷ 3.3 grams/bronze sheet = 30.3 sheets X 2.5 grams/silver sheet

Gelatin

Switching between sheet and powdered gelatin

- An approximate conversion is as follows:

  17 sheets = 1 ounce (28 grams) gelatin powder.

- Conversion depends on actual Bloom rating of powdered gelatin.
  - Always prepare a test batch to confirm that conversion works; adjust as necessary.

  Note: water for blooming gelatin is generally listed in formulas that call for powdered gelatin but not for formulas calling for sheets bloomed in excess water.

Vegetable Gums

Vegetable gums

- Are polysaccharides that absorb large quantities of water.
- Some thicken only; some also gel.
  - Are not gummy when properly used.
- Examples:
  - Pectin.
  - Agar.
  - Carrageenan.
  - Guar gum and locust bean gum.
  - Gum arabic.
  - Gum tragacanth.
  - Xanthan gum.
  - Methylcellulose.

Vegetable Gums

Pectin

- High in certain fruits: apples, plums, cranberries, raspberries, citrus peel.
  - Can be made into jams and jellies without added pectin.
- Produces attractive clear gel, with clean flavor and pleasant mouthfeel.
- Can purchase pure pectin as dry powder.
- Requires proper amount of sugar and acid to gel.
- Uses: mirrors, glazes, jams and jellies, bakery fillings, fruit confections.

Vegetable Gums

Agar

- Also called agar-agar, or kanten.
- Extracted from red seaweed.
- Purchase as strands, flakes, or dry powder.
- To use: boil until dissolved.
  - Strands are first soaked in water, to soften.

Vegetable Gums

Agar (cont.)

- Nicknamed the “vegetable gelatin.”
  - Forms clear gels, similar to gelatin.
  - Cannot be whipped as gelatin can.
  - Used in place of gelatin whenever dietary or religious restrictions warrant its use.
  - Much less agar is needed than gelatin: start with conversion of 8:1, or eight parts gelatin to one part agar.
- Uses: piping gels, gelled confections and desserts, for stabilizing icings and fillings, as a substitute for gelatin (in non-aerated products).

Vegetable Gums

Guar gum and locust bean gum

- Extracted from the endosperm of beans.
- Locust bean gum is also called carob gum.

- Uses
  - In ice cream and frozen pasteurized egg whites, to thicken and prevent ice crystal growth.
  - In cream cheese and sour cream, to thicken, add creaminess, and prevent separation of liquid.

Vegetable Gums

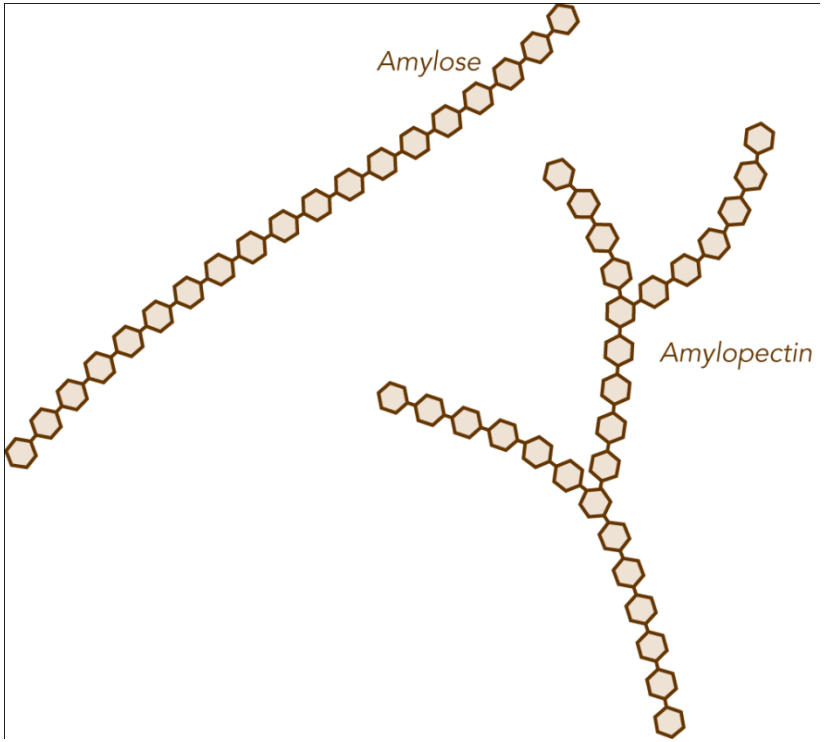
Xanthan gum

- From the fermentation of a microorganism.
- Forms a flexible film that traps air and leavening gases.
- Provides flexibility to doughs; helps them hold together.
- Main use in bakeshop: gluten-free baked goods.

Starches

Starch molecules

- Polysaccharides consisting of many glucose units bonded together.
- Two types.
  - Amylose; straight-chained.
  - Amylopectin; branched.



Starches

Starch granules

- Small gritty particles tightly packed with starch molecules.
- Found in
  - Cereal grains.
    - *Examples*: corn, rice, wheat.
  - Roots and tubers.
    - *Examples*: potatoes, arrowroot, and yuca (also called cassava or manioc).
- Vary in size and shape, depending on the starch.
  - Potato granules are relatively large and oval; cornstarch granules are much smaller and more angular.
- Grow larger as the plant ages.
  - Starch molecules are arranged as concentric rings within the granule, much as growth rings form on a tree as it matures.

Starches

Different starches have different properties because of differences in

- Size and shape of granules.
- Amount of amylose/amylopectin or size of molecules.

TABLE 12.2 COMPARISON OF HIGH-AMYLOSE AND HIGH-AMYLOPECTIN STARCHES

HIGH IN AMYLOSE	HIGH IN AMYLOPECTIN
Cloudy when cooled	Relatively high clarity
Forms a firm, heavy-bodied gel when cooled	Thickens, does not gel
Gel tightens and weeps over time	Much less likely to weep over time
Not freezer stable; tends to tighten and weep	Much less likely to weep when thawed
Much thicker cold than hot	Essentially the same thickness hot or cold
Tends to mask flavors	Less likely to mask flavors

Starches

Cereal starches

- Extracted from endosperm of corn, rice, wheat.
- Cornstarch is most common.
  - Inexpensive and readily available.
  - A general purpose starch.
  - Compared to many other starches, is high in amylose.
  - Has some disadvantages over certain other starches:
    - Cloudy.
    - Not stable in freezer.
    - Has a cereal taste; masks flavors.

Starches

Root starches

- Extracted from the tubers (roots) of plants.
  - Potato, arrowroot, yuca.
- In general, are lower in amylose and higher in amylopectin.
- Use instead of cornstarch:
  - Where clarity, clean flavor, and a soft gel are desirable.
  - In gluten-free baked goods.
    - Gelatinize sooner than cornstarch, for less grittiness.

Starches

Tapioca is most common root starch.

- Extracted from yuca, also called cassava or manioc.
- Processed into pearls, for use in sauces and pie fillings.
  - Require soaking, sometimes for hours or overnight; quick-cooking granules require only short soaking.
  - Reduces stringiness.

Starches

Modified food starch

- Starch is treated with chemicals to modify its properties.
- Main reason for use: stability.
  - Less likely to thin out when exposed to too much heat or acid.
  - Less likely to tighten and weep when frozen.
- Any starch can be modified, but many modified starches are made from waxy maize starch.
- Some are cook-up starches and others are instant.

Starches

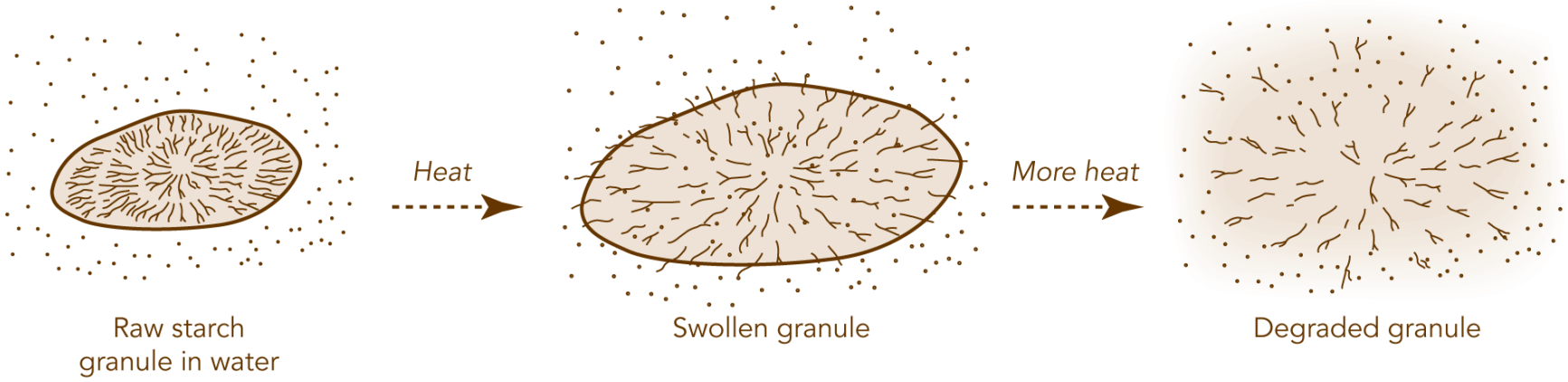
Instant starch

- Thickens and gels without heat.
- Most are also modified, for stability.
- Also called pregelatinized or cold-water swelling starch.
- To use: Slowly add to cold liquids, while whisking or stirring.
  - If necessary, blend dry starch with about four parts sugar or other dry ingredient, to prevent clumping.
- Uses: for last-minute thickening; for heat-sensitive products.

Starches

Starch gelatinization

- Occurs when starch is heated in presence of water.
  - Granules lose their orderliness and swell from large amounts of water moving in.
  - Water becomes trapped inside swollen granules, causing liquids to thicken.
- Too much heat results in degraded granules and a loss of thickening.



Starches

For maximum thickening and gelling:

- Cook for the proper length of time.
  - Follow formula's method of preparation carefully.
  - In general, cornstarch mixtures are boiled gently for two-three minutes.
- Need granules to swell and trap water but do not want granules to degrade.

TABLE 12.3 UNDERCOOKED AND OVERCOOKED STARCH SOLUTIONS

UNDERCOOKED	OVERCOOKED
Too thin	Too thin; may be stringy
Gritty	Smooth
Opaque	Extremely clear
Raw starch taste	No raw starch taste
Tends to weep	Does not weep

Starches

Cook time will depend on:

- Type of starch.
  - Root starches typically gelatinize sooner than cornstarch.
- Presence of tenderizers.
  - Sweeteners and fats slow down the cooking of starch because they slow the swelling of granules.
  - With formulas high in sugar, withhold half the sugar until after starch has gelatinized.
- Presence of acid.
  - Acid speeds up the cooking of starch because it breaks apart starch granules and breaks down starch molecules.
  - With formulas high in acid, reduce cook time, increase the amount of starch, or add acid after mixture is cooked and cooled. Or, use a modified food starch.

Starches

Starch molecules bond over time, once cooled.

- Process is called retrogradation.
- In creams and pie fillings,
  - Gel shrinks and toughens.
  - Weeping often occurs, where water squeezes out of tightening gel.
  - Especially likely to occur:
    - With cornstarch-based products.
    - When products are frozen.
- In baked goods,
  - Crumb stales, that is, it becomes dry, hard, and crumbly.
  - Especially likely to occur
    - With products made from lean doughs, such as baguettes.
    - When products are refrigerated.

Functions of Thickening and Gelling Agents

Providing a thickened or gelled texture.

- Thickening and gelling are forms of structure building.
  - Starch, in particular, contributes to the structure of baked goods.
- Increasing stability.
  - Thickening and gelling agents are sometimes called stabilizers, meaning that they prevent undesirable changes from occurring in foods.

Examples: gelatin and whipped cream; guar gum and frozen egg whites.

Functions of Thickening and Gelling Agents

Providing gloss or sheen to sauces, fillings, and glazes.

- Many thickening and gelling agents form a smooth layer that clings to the surfaces of ingredients.
- Smooth layers reflect light in a way that provides gloss or sheen.

  Example: mirror glazes on cakes, made with gelatin or pectin.

Additional Functions

- Softening and tenderizing baked goods.
- Absorbing moisture.

Storage and Handling

Store gelatin, gums, and starches covered.

- Prevents them from absorbing moisture and clumping.

To use: separate dry particles (gelatin, gum, or starch) before heating.

- Blend with other dry ingredients, such as granulated sugar.
  - Rule of thumb: use about four parts sugar with one part dry starch.
- Blend with fat, such as butter or oil.
- Add first to cold water, to hydrate.
  - Works with cook-up starches, gelatin, agar and many gums.
  - Does not work with instant starches.