

1.5: Gelatinization

Hydrocolloids

A hydrocolloid is a substance that forms a gel in contact with water. There are two main categories: Thermo-reversible gel: A gel that melts upon reheating and sets upon cooling. Examples are gelatin and agar agar. Thermo-irreversible gel: A gel that does not melt upon reheating. Examples are cornstarch and pectin. Excessive heating, however, may cause evaporation of the water and shrinkage of the gel. Hydrocolloids do not hydrate (or dissolve) instantly, and that hydration is associated with swelling, which easily causes lumping. It is therefore necessary to disperse hydrocolloids in water. Classically, this has always been done with cornstarch, where a portion of the liquid from the recipe is mixed to form a “slurry” before being added to the cooking liquid. This can also be done with an immersion blender or a conventional blender, or by mixing the hydrocolloid with a helping agent such as sugar, oil, or alcohol prior to dispersion in water.

Starches

Starch **gelatinization** is the process where starch and water are subjected to heat, causing the starch granules to swell. As a result, the water is gradually absorbed in an irreversible manner. This gives the system a viscous and transparent texture. The result of the reaction is a gel, which is used in sauces, puddings, creams, and other food products, providing a pleasing texture. Starch-based gels are thermoirreversible, meaning that they do not melt upon heating (unlike gelatin, which we will discuss later). Excessive heating, however, may cause evaporation of the water and shrinkage of the gel.

The most common examples of starch gelatinization are found in sauce and pasta preparations and baked goods. In sauces, starches are added to liquids, usually while heating.

- The starch will absorb liquid and swell, resulting in the liquid becoming thicker. The type of starch determines the final product. Some starches will remain cloudy when cooked; others will remain clear.
- Pasta is made mostly of semolina wheat (durum wheat flour), which contains high amounts of starch. When pasta is cooked in boiling water, the starch in the pasta swells as it absorbs water, and as a result the texture of the pasta softens.

Starch molecules make up the majority of most baked goods, so starch is an important part of the structure. Although starches by themselves generally can’t support the shape of the baked items, they do give bulk to the structure. Starches develop a softer structure when baked than proteins do. The softness of the crumb of baked bread is due largely to the starch. The more protein structure there is, the chewier the bread.

Starches can be fairly straightforward extracts of plants, such as cornstarch, tapioca, or arrowroot, but there are also modified starches and pre-gelatinized starches available that have specific uses. See Table 1 for a list of different thickening and binding agents and their characteristics.

Table 1 – Common starches and gels used in the bakeshop

<i>Starch or Gel</i>	<i>Ratio</i>	<i>Preparation</i>	<i>Characteristics and Uses</i>
Cornstarch	20-40 g starch thickens 1 L liquid	A slurry (mixture of cornstarch and water) is mixed and added to a simmering liquid while whisking until it dissolves and the liquid thickens; or Cornstarch mixed with sugar, and cold liquid added Thickened mixture simmered until no starch taste remains	Used to thicken sauces when a clear glossy texture is desired, such as dessert sauces and in Asian-inspired dishes Translucent, thickens further as it cools; forms a “sliceable” gel Sensitive to extended heat exposure, so products become thin if held at heat for long periods of time

<i>Starch or Gel</i>	<i>Ratio</i>	<i>Preparation</i>	<i>Characteristics and Uses</i>
Agar agar	15-30g agar agar sets 1 L liquid	Powder dissolved in cold water Added to cold or simmering liquid Activates with heat, sets when cold	Extracted from seaweed Used in Asian desserts and molecular gastronomy cooking Used in place of gelatin in vegetarian dishes Clear firm texture Does not thin when reheated, thickens more when cold

Waxy maize, waxy rice

Dissolved in cold water 20-40 g starch thickens 1 L liquid

Added to hot liquid while whisking until it dissolves and the liquid thickens

Used in desserts and dessert sauces Clear, does not thicken further as it cools Does not gel at cool temperatures, good for cold sauces Quite stable at extreme temperatures (heat and freezing)

Modified starches

Dissolved in cold water 20-40 g starch thickens 1 L liquid

Added to hot liquid while whisking until it dissolves and the liquid thickens

Modified starches are often used in commercially processed foods and convenience products Modified to improve specific characteristics (e.g., stability or texture under extreme conditions; heat and freezing) Translucent, thickens further as it cools

Pre-gelatinized starches

Powder, dissolved in cold liquid 20-40 g starch thickens 1 L liquid

Added to liquid at any temperature

Used when thickening liquids that might lose color or flavor during cooking Become viscous without the need for additional cooking Translucent, fairly clear, shiny, does NOT gel when cold

Arrowroot

Powder, dissolved in cold liquid 20-40 g starch thickens 1 L liquid

Added to hot liquid while whisking until it dissolves and the liquid thickens

Derived from cassava root Used in Asian cuisines Very clear; possesses a gooey texture Translucent, shiny, very light gel when cold

Gelatin 15-30 g gelatin sets 1 L liquid

Powder or sheets (leaves) dissolved in cold water Added to cold or simmering liquid Activates with heat, sets when cold

Derived from collagens in bones and meats of animals Used in aspic, glazes, cold sauces, and desserts Clear, firm texture Dissolves when reheated, thickens when cold

Gelling agents

Gelatin is a water-soluble protein extracted from animal tissue and used as a gelling agent, a thickener, an emulsifier, a whipping agent, a stabilizer, and a substance that imparts a smooth mouth feel to foods. It is thermo-reversible, meaning the setting properties or action can be reversed by heating. Gelatin is available in two forms: powder and sheet (leaf). Gelatin is often used to stabilize whipped cream and mousses; confectionery, such as gummy bears and marshmallows; desserts including pannacotta; commercial products like Jell-O; "lite" or low-fat versions of foods including some margarines; and dairy products such as yogurt and ice cream. Gelatin is also used in hard and soft gel capsules for the pharmaceutical industry.

Agar agar is an extract from red algae and is often used to stabilize emulsions or foams and to thicken or gel liquids. It is thermo-reversible and heat resistant. It is typically hydrated in boiling liquids and is stable across a wide range of acidity levels. It begins to gel once it cools to around 40°C (100°F) and will not melt until it reaches 85°C (185°F).

Pectin

Pectin is taken from citrus and other tree fruits (apples, pears, etc.). Pectin is found in many different foods such as jam, milk-based beverages, jellies, sweets, and fruit juices. Pectin is also used in molecular gastronomy mainly as a gelling agent, thickener, and stabilizer.

There are a variety of types of pectin that react differently according to the ingredients used. Low-methoxyl pectin (which is activated with the use of calcium for gelling) and high-methoxyl pectin that requires sugar for thickening are the two most common types used in cooking. High-methoxyl pectin is what is traditionally used to make jams and jellies. Low-methoxyl pectin is often used in modern cuisine due to the thermo-irreversible gel that it forms and its good reaction to calcium. Its natural capability to emulsify and gel creates stable preparations.

Increasingly, cooks, bakers, and pastry chefs are turning to many different gels, chemicals, and other substances used in commercial food processing as new ingredients to modify liquids or other foods. These will be outlined in detail in the section on molecular gastronomy.

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