Sip + Science:

The Techniques and Chemistry of Maillard

Welcome!

Culinary Institute of America

This course is presented by the Culinary Institute of America in collaboration with Matchbook Distilling to celebrate our recently released Maillard Liqueur.

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Course Information

Let's dive into the molecular heart of flavor with a masterclass in the Maillard reaction, where precision meets artistry. Designed for the inquisitive palate that seeks understanding, this is not just a class; it's a scientific exploration.

One could argue that cooking is not a series of arbitrary actions but a scientific endeavor, with each step governed by principles and reactions that, when understood, can elevate the mundane to the extraordinary. In this class, we will embark on a journey to decode the complexities of the Maillard reaction through a bit of science and a bit of technique - with Maillard Liqueur cocktails in hand, of course.

With the guidance of Chef Educator George Shannon and Leslie Merinoff from Matchbook Distilling Co., you'll learn not just to cook, but to compose. You'll learn not just to taste, but to analyze, with a new appreciation of the depth of flavor that only the Maillard reaction can achieve. From the golden glow of brown butter to the aromatic complexity of roasted coffee, we will explore the alchemy that transforms basic components into culinary gold.

Learn the best practices for harnessing this reaction in your kitchen and adopt an inquisitive view of cooking, where every meal is an experiment and every drink a discovery. Science is not the antithesis of creativity; it is its foundation. Let us prove this together!

"We ate well and cheaply and drank well and cheaply and slept well and warm together and loved each other."

Ernest Hemingway, *A Moveable Feast*

SIP + SCIENCE:
THE TECHNIQUES AND CHEMISTRY OF MAILLARD

WHAT IS MAILLARD?

PART ONE: SWEET

Maillard Neat

Madeleine

Fireside Fika

Dulce de Leche

PART TWO: NUTTY

Gold Knot

Brown Butter

PART THREE: SULFURIC

Maillard Old Fashioned

Roasted Mushrooms and Garlic

MAILLARD LAB – SOMETHING FOR YOU TO DO AT HOME

WHAT IS THE MAILLARD REACTION?

The Maillard reaction was discovered and described by French physician Louis Camille Maillard in about the year 1910. The complex and intense flavors produced by this reaction went beyond the flavors created by caramelization and was created by more than just sugars. This reaction comes from amino acids and carbohyddrates found in breads, chocolate, coffee, beans, dark beers, and roassted meats. The flavors it produces are found in many of the foods we eat daily and are too numerous to list here.

During this class we will introduce you to three types of Maillard reactions and discuss some of the others that occur. The following chart from Harold McGee's *On Food and Cooking* will help differentiate between the flavors found in the Maillard reaction and caramelization.

Maillard Reaction	Caramelization
Savory (peptides, amino acids)	Sweet (sucrose, sugar)
Floral (oxazoles)	Sour (acetic acid)
Onions, meatiness (sulfur compounds)	Bitter (complex molecules)
Green Vegetables (pyridines, pyrazines)	Fruity (esthers)
Sherry like (acetalaldehyde)	Chocolate (pyrazines)
Butterscotch (diacetyl)	Potato, earthy (pyrazines)
Caramel (maltol)	
Nutty (furans)	Plus caramelization flavors

PART ONE: SWEET

NOT JUST SUGARY

The Drink

Maillard Liquere served neat follwed by Fireside Fika

The Food

Madelines and followed by Dulce De Leche

The Quote

"...this reaction between amino acids (the buiking blocks of proteins) and sugars is one of the most complex and best-studied for creating flavor. Starting with a bigger assortment of molecules than just sugar gives you more material to work with andmore ways to un-knot and re-assemble things, like adding a new set of Lego to your toy bin."

Arielle Johnson, *Flavorama – A Guide to Unlocking the Art and Science of Flavor*

The Chemistry

I. Boiling temps and above starts around 250°F and is strongest/fastest from 280°F - 330°F
II. Involve the interaction of sugars and the amino-acid building blocks of proteins generating a bloom of volatiles.
III. "Their initial encounter with each other triggers a complex reaction cascade, the products of one stage successively reacting to form new sets of products and an increasingly rich aroma." Harold McGee, *Nosedive*

Madeleine

Yield: 70 (3 in.) madeleines

Ingredients	Amounts (Metric)	Amounts (U.S.)
Flour, all-purpose	397 g	14 oz.
Salt, kosher	5 g	1 tsp.
Baking powder	7.5 g	2 ½ tsp.
Lemon, zest	1 ea.	1 ea.
Sugar, granulated	397 g	14 oz.
Butter, unsalted, softened	255 g	9 oz.
Egg, whole	312 g	14 oz.
Milk, whole	150 ml	5 fl. oz.
Vanilla extract	15 ml	½ fl. oz
Pan spray	as needed	
Flour, all-purpose	as needed	

Method

1. Sift together the flour, salt, and baking powder.
2. Place the butter, sugar, and lemon zest in a mixer with a paddle attachment. Cream on medium speed until light and fluffy, about 5 minutes.
3. Combine the eggs, milk, and vanilla. Add to the mixer in two or three additions, mixing until fully incorporated after each addition.
4. At low speed, mix in the sifted dry ingredients. Scrape down the bowl as needed during the creaming and mix to blend evenly.
5. Cover the batter tightly with plastic wrap and allow it to rest overnight under refrigeration.
6. Preheat oven to 375°F.
7. Spray the madeleine pan with pan spray and dust with flour.
8. Fill a pastry bag fitted with a No. 4 plain tip with the cold batter and pipe into the prepared madeleine pans, filling the molds three-quarters full.
9. Bake in the preheated oven until the edges are a medium golden brown, about 10 minutes.
10. Transfer the pans to racks and cool slightly before unmolding and serving.

Note: A simple accompaniment is a neat drink of the nutty, buttery Maillard Granola Liqueur. The madeleine will also pair nicely with the Fireside Fika.

FIRESIDE FIKA

Yield: 1 serving

Ingredients	Amounts
Espresso	1 oz.
Maillard Granola Liqueur	2 oz.
Simple syrup	¼ oz
Tonic water	2 oz.

Method

1. Fill a glass with fresh ice.
2. Add the ingredients to the glass.
3. Stir gently to combine.

Note: In Sweden, this daily occasion is a national treasure known as Fika. It is a perfect drink for a short coffee break or midday treat. For this Fika-in-a-glass, we've combined the almond and grain-forward notes of Maillard Granola with espresso for a taste of coffee and cake to slow down your day accompanied by a taste of Dulce de Leche.

DULCE DE LECHE

Yield: 14 oz.

Ingredients	Amounts
Milk, condensed, sweetened, 14 oz. can	1 ea.

Method

1. Remove the label and glue from the unopened can.
2. Immerse the can in a pot of simmering water for 3 hours.
3. Turn the heat off and allow the can to cool to room temperature. Do not open the can until the can is fully cooled or the pressure will spray hot liquid!
4. Open the can and use in recipes, on ice cream, or in drinks.

Note: This recipe will produce a thick, golden tan dule de leche. A shorter simmering time will produce a lighter color and slightly thinner consistency. A longer simmering time will result in a darker, more intense flavor with a thicker consistency.

PART TWO: NUTTY

TREES NOT REQUIRED

The Drink

Gold Knot: a smokey twist on a sour

The Food

Bread and Butter: bread served with clarified butter, buerre noisette (golden brown), and buerre noir (dark brown)

The Quote

"With the oysters I drank white wine, cold, not too dry, and ate narrow strips of bread and butter. It was a pleasant café, warm and clean and friendly, and I hung up my old waterproof on the coat rack to dry and put my worn and weathered felt hat on the rack above the bench and ordered a café au lait."

Ernest Hemingway, *A Moveable Feast*

The Chemistry

Follow the recipe for Beurre Noisette.

The Tasting Notes

The result? A nutty, complex, and deeply satisfying flavor that can elevate a simple dish to the realm of the sublime. The Maillard reaction in brown butter is a prime example of how understanding the science in the kitchen can turn everyday cooking into an art.

GOLD KNOT

Yield: 1 serving

Ingredients	Amounts
Maillard Granola Liqueur	1 oz.
Late Embers Sunchoke + Honey	1 oz.
Lemon, juice, fresh squeezed	¾ oz.
Simple syrup	½ oz.
Lemon, slice	1 ea.

Method

1. Build the drink in a shaker tin with fresh ice.
2. Shake to mix all the ingredients.
3. Strain into a rocks glass over a large ice cube.
4. Garnish with a lemon slice.

BROWN BUTTER
BEURRE NOISETTE

Yield: 6 oz.

Ingredients	Amounts
Butter, whole, unsalted	6 oz.
Salt, kosher	as needed
Pepper, black, freshly ground	as needed

Method

1. Heat a sauté or saucepan over medium-low to medium heat.
2. Place the whole butter in the pan and heat until the milk solids separate from the butter fat.
3. Continue cooking the butter until it turns a golden brown, noisette color, 2 to 4 minutes.
4. Remove the pan from the heat and serve immediately or dip the pan in cold water to stop the cooking process.

Note: Depending on the use, a pinch of seasoning will improve the flavor. The pan should be hot enough to start browning the butter, but not so hot that the butter burns immediately. Beurre Noir is achieved by browning the butter a few moments longer. Remember that the cooking temperature will greatly impact the timing of the finished product.

The Chemistry

I. When you gently heat butter, the first thing you'll notice is that it melts—this is the simplest part of the process. As the heat continues, water within the butter evaporates, and the milk solids start to fry in the fat, leading us to our main event: the Maillard reaction. This isn't mere cooking; it's an alchemical transformation where amino acids and sugars conspire to delight your taste buds.

II. In butter, the amino acids largely come from the proteins found in milk solids—specifically, casein and whey proteins. These proteins break down into amino acids like lysine, which is particularly reactive in the Maillard reaction. As for the sugars, they're primarily lactose in butter. When these amino acids and sugars meet at high heat, they undergo a series of reactions that result in new flavors and brown pigments. This isn't burning (which is what happens when you overdo it and end up with a blackened mess); it's controlled culinary chemistry.

III. Lysine is a rock star in the world of maillard reactions due to its unique chemical structure – uniquely fond of reacting with sugar under the influence of heat – a propensity for maillard reactions.

IV. Let's explore when and how butter morphs from butter to brown butter.

a. **Melting** (90-95°F): transitioning from solid to liquid state, milk solids dispersing evenly in the fat, setting the stage for reactions.

b. **Foaming** (212°F): as the temp rises the water begins to evaporate leading to foaming – at this stage the proteins start to denature, the proteins begin unfolding.

c. **Denaturation and breakdown**: (212F – 248°F), water has evaporated so now we can get to higher temps, that heat causes the now denatured proteins to break down into their constituent peptides and amino acids – lysine! This stage is critical for the reactions to occur.

d. **Maillard Reaction + Browning:** (302°F+): the freed amino acids react w the reducing sugars present in the milk solids – a cascade of reactions creating the golden hues and the complex, nutty flavors characteristic of brown butter.

e. **Final Stages:** if the heat continues, the risk of burning increases as the sugars and proteins might degrade too far – an acrid taste develops.

The Tasting Notes

The result? A nutty, complex, and deeply satisfying flavor that can elevate a simple dish to the realm of the sublime. The Maillard reaction in brown butter is a prime example of how understanding the science in the kitchen can turn everyday cooking into an art.

PART THREE: SULFUR

NOT ALWAYS A BAD FLAVOR

The Drink

Maillard Liquere Old Fashioned

The Food

Steamed and roasted mushrooms and garlic

The Quote

"Gently the sauté pan heated up over the flame, the mushrooms began to give off a quiet, singing sound, and gradually their fresh, raw aroma was replaced by a richer, deeper smell. They gave up their liquid, it evaporated, and the sound of the cooking changed in tempo."

Haruki Murakami, *Kafka on the Shore*

MAILLARD OLD FASHIONED

Yield: 1 serving

Ingredients	Amounts
Maillard Granola Liqueur	2 oz.
Bitters, barrel aged	few dashes (to taste)
Orange, peel, cut into a strip	1 ea.

Method

1. Fill a mixing glass with fresh ice.
2. Add the ingredients and stir gently to combine.
3. Strain into a rocks glass over a large ice cube.
4. Garnish with orange peel.

Note: A cocktail cherry on a skewer would also be an appropriate garnish.

ROASTED MUSHROOMS AND GARLIC

Yield: 6 portions

Ingredients	Amounts
Mushroom, cremini	½ lb.
Mushroom, shiitake	½ lb.
Garlic, clove, whole, peeled	6 ea.
Oil, olive, extra-virgin	2 Tbsp.
Rosemary, fresh, rough chopped	1 Tbsp.
Salt, kosher	as needed
Pepper, black, ground	as needed

Method

1. Preheat oven to 425°F.
2. In a large stainless-steel bowl, place the mushrooms and garlic and toss.
3. Add the olive oil and toss to coat.
4. Season with the rosemary, salt, and pepper. Mix thoroughly.
5. Transfer the vegetables to a roasting or sheet pan.
6. Place in the preheated oven and roast until the vegetables are browned and tender. Gently stir the vegetables periodically throughout the cooking period to ensure even roasting.
7. Serve hot on a heated platter.

The Chemistry

I. Sulfur containing amino acids (cysteine and methionine)

II. nutty, meaty, and savory notes

III. The sulfur in the amino acids can contribute to these flavors, enhancing the umami characteristics that mushrooms are known for. This reaction is crucial for creating the deep, rich taste and golden-brown color that makes cooked mushrooms a delicious addition to many dishes.

IV. Garlic is notable for its high sulfur content, including cysteine. When roasted, it undergoes caramelization and maillard reactions which mellow its pungency and enhance its sweetness.

The Stages

I. Heating and Water Evaporation: mushrooms are over 90% water, so removing this water is critical.

II. Concentration of Flavors: the reduction of water concentrates the flavor and aroma molecules that increase what we taste and smell. Be careful to avoid excess.

MAILLARD LAB

SOMETHING FOR YOU TO DO AT HOME

Maillard Lab

PROJECT NAME: Sip + Science

TIMELINE: June 1, 2024 **LOCATION** CIA Hyde Park

OBJECTIVE	• The primary objective of this experiment is to observe and analyze the stages of butter as it transitions from melted to browned to burnt. The focus will be on identifying the key chemical reactions, particularly the Maillard reactions, that contribute to changes in color, aroma, and flavor during these stages.
BACKGROUND	• Butter browning is a culinary process that enhances the flavor of dishes through the development of complex brown compounds and a nutty aroma. This transformation involves both Maillard reactions and caramelization. The Maillard reaction is a chemical reaction between amino acids and reducing sugars that gives browned foods their distinctive flavors. This experiment will dissect the stages at which these reactions occur and the sensory changes that result.
MATERIALS	1. Unsalted butter (100 grams) 2. Skillet or heavy-bottomed pan 3. Stove or heating element 4. Thermometer capable of measuring up to 250°C (482°F) 5. Spatula 6. Timer 7. Note-taking materials (notebook and pen)
TIMELINE	1. Setup: Place the skillet on the stove and heat it to a medium setting. Ensure all safety equipment is worn. 2. Melting: Add butter to the skillet and observe as it melts completely. Record the temperature and the time taken for the butter to melt. 3. Heating: Continue to heat the butter, stirring occasionally with the spatula. Monitor and record the temperature at regular intervals (every 30 seconds). 4. Browning: Observe the changes in color from yellow to golden to brown. Note the formation of foam and the subsiding thereof as the water content evaporates. 5. Sampling: As the butter changes color, take small samples onto a white plate at various stages to visually document the color changes. 6. Aroma Analysis: Record any changes in aroma during the heating process, noting when nutty or caramel-like smells become evident. 7. Burn Point: Continue heating until the butter starts to smoke and turn dark brown. Record this temperature as the burn point. 8. Cooling: Remove the skillet from heat to prevent further burning and allow the butter to cool. Collect the final sample.

PORCH SWING

Yield: 1 serving

Ingredients	Amounts
Maillard Granola Liqueur	2 oz.
Strawberry Daytrip or strawberry infused Campari	2 oz.
Eldest Daughter vermouth or other dry floral vermouth	2 oz.
Simple syrup (optional)	¼ oz.
Lemon twist	1 ea.

Method

1. Fill a mixing glass with fresh ice.
2. Add the ingredients to the mixing glass.
3. Stir gently to combine.
4. Strain into a coup glass, Serve with a lemon twist.

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This syllabus was developed using the resources of The Culinary Institute of America.

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