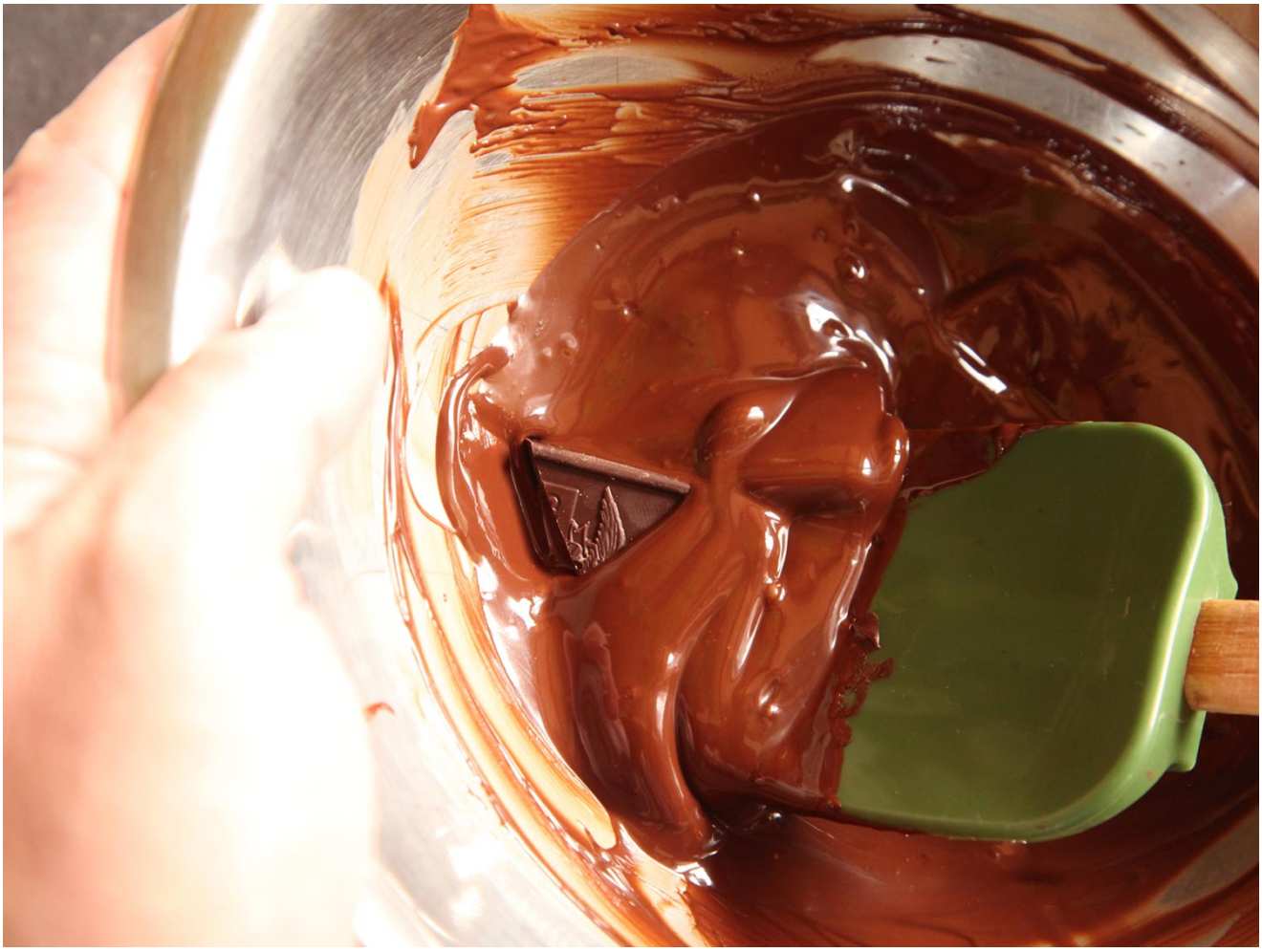
The Food Lab: The Best Way to Temper Chocolate

The Food Lab[1]
Unraveling the mysteries of home cooking through science.



Seeding chocolate for perfect crystal formation. [Photographs: J. Kenji Lopez-Alt]

All About Chocolate[2]

Everything you want to know about chocolate

In the list of culinary disasters I've had in my life, the Great Chocolate Seizing Incident of '01 ranks high on the list. I was still a part-time cook and college student at the time, but I'd agreed to cater a big party for our fraternity house, cooking a meal for around 100, soup to nuts. This was nothing new. What *was* new was the chocolate candies I was planning on

making to serve along with the coffee after the meal. *Just melt chocolate, pour it into molds, add some flavorings, and let it set? That's child's play*, I thought to myself.

Everything was going well through the melting phase. I had no problem getting liquid chocolate to pour into my molds. But those darn candies refused to firm up! Even after an hour in the fridge, they were soft and melty to the touch. Figuring I'd try again, I re-melted that chocolate, this time while I was busy working on other projects. When I went back to the bowl and started stirring, the chocolate started forming grainy lumps. *Crap. What do I do?* I thought. *I know! I'll bet the chocolate just lost too much moisture as it was warming up. I'll add some hot water to it. That's the ticket!*

I started stirring vigorously as I trickled in a little stream of steaming hot water. Almost instantly, the chocolate seized up into a grainy, dull, broken mess.

Luckily, folks were drunk enough by the time coffee service rolled around that nobody missed the chocolate.

This was my first and most humbling foray into the world of chocolate-making, and since then I've learned how tricky chocolate can be to work with and the importance of proper tempering. It's not something you need to know if you're just making a chocolate cake or perhaps a ganache, but if dipping, decorating, or making chocolate candies is your goal, it's an essential technique in your repertoire.

There are many ways to temper chocolate, some involving more equipment than others, but I'm going to go over the ones I think are most suited for home cooks. The first is the classic stovetop or microwave method. The second is a method I picked up from Alton Brown, which uses a food processor and a hair dryer. The third—and to my mind best—is using a sous-vide cooker. You can jump straight to any of the techniques below, or read on for mored details on the hows and whys.

To temper chocolate properly, there's no two ways about it. You *will* need a good thermometer like the Thermapen[3] or Thermopop[4].

Once you've got that thermometer, there's really not much more to it.

Structure and Crystals: Why Chocolate Must be Tempered

With most cooking fats and liquids, there's a magic temperature above which they're liquid and below which they're solid. Simple, right? Chocolate, on the other hand, follows its own set of rules. Sure, it has a melting temperature, but depending on precisely how long it's been held at a given temperature or how forcefully it's been agitated, its texture once solidified can vary drastically.

> *Well-tempered chocolate should set up with a smooth, lightly glossy finish and a firm snap.*

Why is this? It's because cocoa fat, the primary constituent in chocolate that gives it its solid texture, can form various types of crystals ranging from loose and unstable to well-structured and firm. *Tempering* is the process of heating chocolate to a series of precisely defined temperatures and working it in order to maximize its chances of forming a tight, stable structure. Well-tempered chocolate should set up with a smooth, lightly glossy finish and a firm snap. Poorly tempered chocolate may appear mottled, spotted, or pale, with a soft, sometimes grainy texture.

Poorly tempered chocolate or chocolate that has not been agitated enough during tempering will form streaks with a dull appearance.

Sounds confusing, right? But it's actually pretty simple. It helps to think of cocoa fat as a bag that's filled with lego bricks along with an army of elves on-call to snap them together. The goal is to get those elves to assemble all of the lego bricks into a solid, stable wall. Depending on the temperature range at which you hold the chocolate, these bricks get assembled in different ways.

- **At 115°F and above (46°C):** it's simply too hot for those elves to work. The chocolate is completely melted, and no structure will be formed.
- **Between 88 and 92°F (31 to 33°C)** you've got ideal working conditions. The elves work together, adding bricks a few at a time to the wall, starting from the bottom up, eventually building a nice, solid structure.
- **Below 88°F (31°C):** the cold distracts the elves. Rather than working as a team, they start to work individually, snapping together bricks as fast as they can. The end result is a disorderly mess of masses of different shapes and sizes, none of which can be put together into a solid structure.

Put into pure chocolate terms, when you heat chocolate above 115°F, it melts completely. Lower the temperature too rapidly and you'll end up forming very unstable crystals, creating chocolate that doesn't firm up properly and has a dull appearance. If, on the other hand, you hold it in that magical 88 to 92°F long enough for most of the cocoa fat molecules to align

themselves properly, subsequent cooling should produce a perfectly snappy coating on your strawberries, biscotti, or whatever else it is you like to dip into chocolate.

Properly tempered chocolate will form a smooth, hard surface with good snap.

If you want to get into more nitty gritty details, chocolate crystals form into six distinct shapes (Forms I through VI), each type of crystal forming and melting at a specific temperature range. Form V, also known as Beta Prime, forms in that sweet spot around 90°F, and is the form that we're after. While theoretically you *could* get your chocolate to form perfect Form V crystals by simply heating it to 115°F until fully melted, then lowering it and holding it at 90°F, in reality, the crystals take a long, long time to form, which is why almost every technique for tempering chocolate will have you first lower the temperature of the chocolate to around 81°F (27°C), which promotes rapid formation of both Form V and Form IV crystals, then raise it back up to 90°F, causing the Form IV crystals to melt but the Form V crystals to remain intact.

Is all this talk of molecules and crystals numbing your brain? Yeah, it does that to me too. But don't worry, most of this is stuff you don't really need to know to get your chocolate to temper correctly. If you love this kind of nerd-talk, I highly recommend picking up a copy of *Peter Greweling's Chocolates and Confections: Formula, Theory, and Technique for the Artisan Confectioner*[5] for a more in-depth discussion with pretty graphs and charts.

When Tempering Goes Wrong: Worst Case Scenarios

Say you're tempering a batch of chocolate and your mother-in-law calls from the land of in-laws and you end up tempering while distracted with a phone tucked between your cheek and your shoulder. What's the worst that can happen? Actually, it's pretty bad. In some cases irreversible. Here are the three worst case scenarios.

Scenario 1: Water

Chocolate has no water in it. Chocolate hates water. Even a single drop of water falling into a bowl of melted chocolate can destroy it. As soon as that drop falls in, the crystal structure of the the entire bowl of chocolate will break very rapidly and you'll end up with a grainy, broken mess that cannot be recovered. This is a chocolatier's worst nightmare. You have been warned.

Scenario 2: Overheating

Pastry and confectioners will refer to chocolate "burning." This is what happens if you heat chocolate to around 145°F (62°C) or hotter. In point of fact, the chocolate isn't really burning, but it *does* break down to the point where it'll seize up into an unrecoverable state. Just as with the water scenario, if your chocolate hits this stage, you're gonna have to head back to the store for a fresh batch.

Scenario 3: Overcooling

Say you're tempering your chocolate and you're at the cooling phase. What happens if you accidentally drop below 81°F? You end up forming too many Form III or lower crystals, all of which can inhibit you from forming good Form V crystals later on when you reheat it. This is not the end of the world. Your best bet is to reheat it up to 115°F again and start over.

With the science lesson out of the way, let's jump straight into the techniques.

Chocolate Tempering Method #1: The Stovetop or Microwave

Advantages: Requires no special equipment other than a thermometer.

Disadvantages: Least foolproof. Requires a minimum of 12 ounces of chocolate. Lots of clean-up. Lots of wasted chocolate in the bowl and on the spatula.

The Short Version: Melt at least a half pound of chocolate by stirring it in a bowl set over a pot of simmering water or by microwaving it in a bowl at 30 second intervals, stirring between each stint in the microwave. Once it hits 115°F, drop in chunks of un-melted fresh chocolate a few at a time, stirring vigorously after each addition until the chocolate drops back down to 81°F. Finally, reheat the chocolate to between 88 and 90°F, making sure that it never rises above 92°F. Dip or pour as desired.

The Long Version:

This is the most classic way of tempering chocolate, and it begins by first melting the chocolate to completely rid it of all crystals. You can do this either by placing chunks of chocolate or chocolate chips in a bowl set over a pot of simmering water and stirring

frequently with a spatula, or by placing the chocolate in a bowl and microwaving it at 30 second intervals, stirring between each batch until fully melted. The latter is the method I used for these photos.

When fully melted, your chocolate should be somewhere between 115 and 120°F or so. In an absolutely ideal world, you technically don't *need* to heat your chocolate this much, assuming you're starting with chocolate bars that are well-tempered to begin with, but I find that more often than not, you get better results by fully melting the chocolate before cooling it.

On to the cooling phase. At this stage you *could* stand and stir the chocolate at room temperature until it drops down to 81°F, then reheat it to 90°F to form those Form V crystals, but this would take a long, long time. A much more efficient and bulletproof method is to use a technique called *seeding*.

How Seeding Works

Raise your hand if you've read Kurt Vonnegut's classic novel *Cat's Cradle*[6]. In it, scientists develop a new form of crystalline water that they call ice-nine. It has the unique property of being able to induce any liquid water molecules it comes into contact with to join its formation. Drop a crystal of ice-nine into a bucket of water and that entire bucket of water will rapidly seize up into one large, solid block of ice-nine. Of course, this is a Vonnegut novel, so eventually somebody drops a crystal into the ocean, thus destroying the world.

There are many philosophical and moral lessons to be learned from that book, but what's interesting is that chocolate behaves very much like ice-nine. Adding just a smidgen of well-tempered chocolate to a bowl of liquid chocolate can induce that liquid chocolate into forming more good crystals and fewer weak ones. That's the idea behind seeding.

By adding chunks of un-melted, well-tempered chocolate to a bowl of melted chocolate, not only do you speed up the cooling process, but you also make it more likely that good crystals will form.

Once the chocolate has chilled down to 81°F, place it back over the double-boiler or microwave it again, this time at 15-second intervals between stirs, and bring it up to between 88 and 90°F. Let it sit in that temperature range, stirring it vigorously with the spatula for about five minutes or so (you'll need to place it back and forth over the double boiler or find a good warm spot in your kitchen), and it should have formed enough good crystals to now be ready to set, dip, or pour.

To test it, dip a knife blade into the chocolate and let it rest in your fridge for about three minutes. If it comes out soft or it melts to the touch, it hasn't tempered correctly. Your best bet is to repeat the whole process. If it comes out streaky but semi-firm, it means that you need to beat it a bit more vigorously. If it comes out hard and snappy, congratulations, you've tempered your chocolate perfectly!

Do bear in mind that if this happens:

I.E. your chocolate overheats, you'll have to start over from scratch. And for the love of god, I reiterate: do *not* let even a drop of water fall into that chocolate unless you want to fall victim to Cat's Cradle apocalypse-type results.

Chocolate Tempering Method #2: The Food Processor/Hair Dryer Technique

Advantages: Almost foolproof.

Disadvantages: Requires a food processor (and a hair dryer). Lots of clean-up. Needs a minimum of eight ounces of chocolate. Lots of wasted chocolate in the bowl and on the spatula.

The Short Version: Place chocolate chunks in a food processor. Process until if forms small grains that start to stick together. Continue processing while blowing hot air into the bowl with a hair dryer, scraping down sides as necessary until chocolate hits 115°F on a thermometer. Add chunks of fresh chocolate and pulse until temperature drops to 81°F. Re-process with hair dryer until it rises back up to between 88 and 90°F. Dip or pour as desired.

The Long Version:

I first saw this method on an episode of Alton Brown's Good Eats where he's making Rocky Road Bark[7]. I thought it was genius. The idea is that the friction of the blades bashing the chocolate around inside the processor naturally raises its temperature, all while agitating it extremely efficiently. A hot hair dryer gets rid of any stubborn un-melted pockets.

That said, I think the episode *does* oversell its ease just a bit. In his instructions, he has you process chocolate in a food processor, letting it rest occasionally, until it hits 90 to 91°F. This works reasonably well, but doesn't give you nearly as good a temper as following a more traditional tempering curve, raising the temperature to 115°F, then cooling and reheating. I also found that when using less than a pound or so of chocolate, the chocolate would form a ball that would stick to the side of the processor and refuse to drop back down into the blades, making it frustrating to work with.

I've had batches where I had to break up that darned ball over a dozen times until it finally heated enough to smoothly melt.

To address this, I've tweaked his method to use a more traditional tempering curve and to make more liberal use of the hair dryer for faster, easier results, even with as little as eight ounces of chocolate.

I start by breaking up the chocolate and placing it in the food processor.

I run the processor until the chocolate is completely chopped and starts to clump together. As soon as you see the chocolate start to form a lip that overhangs the blades like this, start applying heat with a blow dryer.

I blow hot air directly into the feed tube of the processor, watching carefully as it goes and scraping down the sides as necessary.

Once the chocolate hits 90°F, there's a small chance that it's in good temper. To test it, dip a knife blade into the chocolate and let it rest in your fridge for about three minutes. If it's hard and snappy, lucky you, you're done!

If, on the other hand, it's soft or dull in appearance, you'll have to continue heating the chocolate until it hits 115°F using the processor and the blow dryer. Once it gets there, add a few chunks of seed chocolate and incorporate them by pulsing. Hitting it with the dryer set on the "cool" setting will also expedite the process. Once it drops down to 81°F, reheat it again using the hot dryer with the processor running until it hits between 88 and 90°F. Your chocolate should now be ready to use.

Chocolate Tempering Method #3: The Sous Vide Circulator

I understand not everyone has a sous vide circulator, but with even the best model coming in at a modest $179[8], there's never been a better time to jump into the game. For my money, the sous vide circulator is the best, most foolproof way to temper chocolate, with the added advantages of being able to temper even small amounts perfectly, and to be able to easily

store leftovers in a form that's ready-to-go the next time you need tempered chocolate. Here's how to do it.

Advantages: Almost 100% foolproof. Can be done with any amount of chocolate. Virtually no clean-up. Easy to re-store chocolate that isn't used for next time with almost no waste.

Disadvantages: Requires a sous vide cooker.

The Short Version: Vacuum seal any amount of chocolate in a bag. Drop it into a water bath set at 115°F and let it sit until completely melted, about 5 minutes. Set your sous vide cooker temperature to 81°F and add ice to the water bath until the temperature drops to 81°. Set your temperature to 90°F and let the chocolate heat up, lifting the bag out of the water once every minute and squeezing it around to agitate it as it warms up. Hold the chocolate at 90°F until ready to use. Snip off the corner and pipe or drizzle as required. Reseal the corner of the bag to store the chocolate for your next use.

The Long Version:

This method at first seems like a total no-brainer. Chocolate requires precise temperature control, and a sous vide cooker is designed for precise temperature control. My first thought was to simply vacuum seal some chocolate and drop it into a water bath set at 90°F. Theoretically, all of the crystals other than Form V should melt away, leaving me with a bag full of perfectly tempered chocolate.

Unfortunately, reality didn't pan out that way. Even after an hour of sitting in the bath, the chocolate was still just barely soft to the touch.

Turns out that if you're starting with well-tempered chocolate (and good store-bought bars are always in perfect temper), it takes a lot of effort to melt those crystals down to a workable consistency—further proof that even at the exact same temperature, chocolate can have a huge range of textures and viscosities depending on how it arrived. It's almost like chocolate has memory.

Instead, I decided to use the sous vide circulator to follow a more traditional tempering curve, starting by dropping my bagged chocolate into a 115°F water bath (because a water bath is an extremely efficient method of heat transfer, it melts the chocolate within minutes).

Next, I lowered the temperature of my circulator to 81°F and added ice cubes to the pot until the temperature dropped down to that level. Finally, I increased the temperature to 90°F and let the chocolate slowly heat up. Once it hit 90°F, I let it sit for five minutes in order to give my crystals some time to form.

Frustratingly, after piping some out onto a plate to test its consistency, I ended up with chocolate that hardened with streaks and spots. What's up with that ?

If I'd been wise, I would've read Scott Heimendinger's post on tempering chocolate sous vide[9]. He had the same problem I did: spotty chocolate.

The issue, I figured, was that inside those sous vide bags, I failed to agitate my chocolate enough, an essential step for even crystal formation. The solution was obvious and simple: squeeze that bag as the chocolate tempers.

By removing the bag from the water bath once a minute and giving it a good, thorough squeeze to mix the contents around, I ended up with the most perfectly tempered chocolate yet, and what's more, I found that so long as you keep the chocolate in that 90°F water bath, it stays perfectly tempered and ready-to-use for a long, long time (I tested it up to 12 hours). Just take it out of the bath, give it a few good squeeze to agitate it, and you're good to go. Gone are the days of tempering your chocolate and having to use it within minutes of tempering before it has a chance to cool off too much.

The best part? There's almost no waste whatsoever. With traditional chocolate tempering methods, you end up with streaks of chocolate around the sides of your bowl or on your spatula, no matter how careful you are. With the sous vide method, all you do is carefully dry the outside of the bag (remember: water is the enemy of tempered chocolate), snip off the corner of your bag and it's ready to pipe or drizzle wherever you want to put it.

I squeezed a bit onto a thin slice of homemade brioche a friend of mine had given me recently. The chocolate pooled out into a thin, glossy layer that solidified to a perfect snap as I let it cool.

Pretty, right?

And I take back what I said about the best part. The *best* best part is that storage and clean up is so darned easy. You don't have to wash any bowls, food processors, or spatula. All you have to do is squeeze the chocolate away from the open corner of the vacuum bag, stick it back in your vacuum sealer, and re-seal the edge.

Your chocolate is now perfectly contained, will hold indefinitely at room temperature, and is ready to re-temper for the next time you need good melted chocolate.

Think about that: it completely solves one of the major problems people have with tempering chocolate using traditional methods, the fact that you have to temper a large amount and clean up bowls and tools. Add to that the fact that it's completely foolproof and I would say you've got yet another reason why a sous vide circulator[10] should be in your kitchen's arsenal.

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