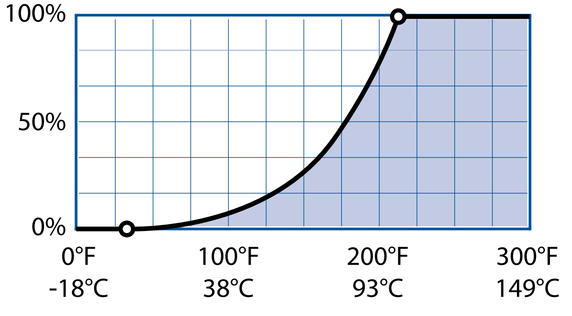
Air, Hot Air, and the Power of Steam

If the ancient Greeks wrote cooking magazines, they probably would have listed fire, earth, water, and air as ingredients. Aristotle and other philosophers of his day considered these four classical elements to be fundamentally indivisible. Their proof? Adding water to fire didn't create more of either but instead created a new "structure" they called steam.



Maximum Percentage of Water Vapor by Temperature:

Hot, humid weather means more water vapor heating up your food as it bakes.

While the ancient Greeks had a rather simplistic understanding of the science, they were on to something with their ideas about water and fire: the properties of air do change with temperature. As the temperature of air goes up, so does the potential amount of water in it. This is subtle but important: air—mostly nitrogen and oxygen, normally only 0.5 to 1% water vapor—can hold more water vapor as it heats up, *if there is a source of water*.

Water vapor matters in cooking because of what it does when it cools down. Technically, steam isn't the same thing as water vapor. In science, steam refers to water droplets suspended in air while water vapor is invisible. I'll use the science definition when talking about science. As temperature drops, the maximum percentage of water vapor in air also drops. At some point there will be too much water vapor dissolved in cooling air, causing it to condense (that point is called the *dew point*). You probably normally think of condensation as something that happens on a glass of iced tea on a hot summer day, but it happens in your oven too! A cold ball of cookie dough going into a hot oven will cause the air around it to cool and the water vapor in that air to condense.

Professional chefs often use *combi steamers*—ovens that control both humidity and temperature. Perhaps this will be standard for home ovens someday; until then, most of us are stuck with squirt bottles and pans full of water.

Water vapor gives off an immense amount of heat when it condenses. The more water vapor there is in your oven, the stronger a thermal punch your cool cookie dough or cake batter is going to take from condensation and the quicker it's going to heat up. A hot, dry oven will take longer to cook food than an oven at the same temperature but full of water vapor. Steam is powerful!

When you put a batch of cookies in your oven, hot air heats the cookie dough in two ways: convection and condensation (see page 143 for definitions). Convection is easy enough to imagine: hot oven air circulates over the surface of cold food, warming it up. (If your oven has a "convection" setting, that means it has a fan inside blowing air around, circulating that air faster. Using convection mode causes foods to cook faster and dry out faster, which is great for crispy pastries and crunchy breads but not so great for steamed buns or custards.)

Condensation is tricky to understand because we don't normally think about water vapor in our recipes (when's the last time you saw a recipe that says set oven to 50% humidity?!). Changes in your kitchen's humidity will change how foods cook from one day to the next, speeding up or slowing down how quickly they heat.

There's no universal perfect humidity. To get a thick crunchy crust on rustic bread or crispy skin on roasted chicken, the surface needs to dry out, so you need a drier oven, at least toward the end of cooking. (Maillard reactions don't happen when liquid water is around; see page 236.) If you're making dinner rolls—breads with soft, lighter-colored surfaces—you'll want a more humid oven. For steamed buns you need an even more humid cooking environment, like a steamer or rice cooker.

Adding humidity is easy enough: as your oven heats, add a baking pan of water on a lower shelf and keep it topped off. Or use a spray bottle and mist your oven before putting your dish in, taking care not to spray the light bulb (it can shatter!). Removing humidity is tougher: using an air conditioner or dehumidifier in the kitchen is your best bet.

Think about the culture and the climate in which a recipe originated. The original bakers wouldn't be fighting against their environment; they would have adapted recipes and the desired outcome to suit their climate.

Humidity is more important for foods that involve yeast. Yeast and the enzymes it relies on are all temperature-sensitive: yeast generates carbon dioxide most rapidly at around 90–95°F/32–35°C. Enzymatic reactions that the yeast relies on speed up as temperature increases, but at some point the enzymes denature and promptly stop working. (Most enzymes are proteins created by an organism and are used to break down other substances; like all proteins, they "cook" too.) *Oven spring*—the additional rise that dough undergoes when it first goes in the oven—depends on how quickly the surface of the bread dries out, how much sugar the enzymes produce, and how quickly the dough heats up (and thus how long the yeast survives).

The second major issue you'll face in baking is the weather. Wintertime means lower humidity and colder indoor air temperatures, slowing down the time it takes for yeast to work (try letting the dough rise on top of your fridge or near a radiator). Summer weather brings higher humidity, leading to the chance that cakes won't develop a strong enough "exoskeleton" and will fall (try using less water). Or it might rain one day (100% humidity, at least at room temperature), but a week later the air might drop down to 50% humidity. That's twice the difference in the amount of water vapor and a major difference in how quickly things heat up without any change in room or oven temperatures. Careful attention to humidity, rise time, and room temperature can solve baking mysteries.

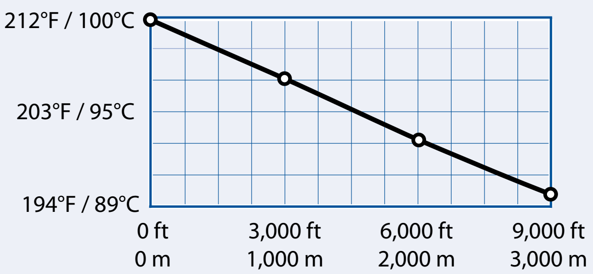
Have you checked your oven? If not, see the sidebar "The Two Things You Should Do to Your Oven RIGHT NOW" on page 35.

The other reason air is so critical in baking is the physical volume it takes up inside the food. Air expands as it heats up. Because most baked goods "set" with heat, the more air there is to expand, the more space it will take after baking, assuming egg proteins on the inside or flour starches on the outside set enough to create the necessary scaffolding to support everything after cooling.

How air gets into your batters and doughs will end up taking the rest of this chapter to explain. Recipes that use *rising agents*—anything that generates gas (yeast, baking soda)—rely on them to generate volume with small bubbles, almost always carbon dioxide. Anything without a rising agent, such as popovers, meringues, and soufflés, can rise only by either the expansion of already-present gas or water evaporating into gas. Regardless of the source, understanding and controlling air is an important part of the science of great baking.

Elevating Your Cooking: Tips for Altitude

Whether you're camping in Colorado or baking in the Swiss Alps, the lower air pressure from being at elevation can cause all sorts of headaches: too-coarse crumbs, fallen cakes, and of course sunburn from enjoying the gorgeous terrain. Here are two key points:



Boiling point of water by altitude

Air bubbles in doughs and batters will expand more—potentially too much. Using yeast? Decrease the fermentation time. Chemical leaveners should be cut back by 10–25%; egg whites should be whisked to a slightly less stiff point. For doughs, making them sturdier will help avoid big internal air pockets; see the tips on increasing gluten on page 249 to figure out how to adjust your recipe.

Water will evaporate faster, leading to drier baked goods and more evaporative cooling. If your foods aren't browning well, bump the heat up by 15–25°F/10–15°C to compensate for the increase in evaporative cooling. For batters, compensate by adding a ~10% quantity of water based on the volume of the liquid ingredients.

Adding salt to water raises the boiling point —fully saturated saltwater boils about 4°F / 2°C higher. It also increases the temperature of steam coming off of the water! If you're at altitude and steaming something, adding salt to the water will bump the temperature up a few degrees.

Steam-Powered Popovers

A popover *is a quick roll that rises entirely by water expanding as it turns into a gas. You can make savory versions by adding grated cheese and herbs, but my favorite is based on what my mom made when I was growing up: buttery popovers with a spoonful of strawberry or apricot jam, served for weekend breakfast.*

Popovers are hollow. They're unlike almost any other baked good—a descendant of Yorkshire pudding and cousin of Dutch baby pancakes. As the batter cooks, the top surface sets before the interior does, and as the interior cooks, water boils off into water vapor that is trapped by the top surface.

Traditionally, these are made in specialized popover cups, which are narrow, slightly sloped cups that have some heft to them, giving them good heat retention. Using muffin tins or ramekins works just as well.

Whisk together in a mixing bowl or blend in a blender:

1½ cups (355mL) whole milk
3 large (150g) eggs
1½ cups (210g) flour (try half all-purpose, half bread to up the gluten content)
1 tablespoon (15g) melted butter
½ teaspoon (3g) salt

Preheat both the oven and the popover cups or muffin tin at 425°F / 220°C.

Heavily grease the popover cups or muffin tins with butter: melt a few tablespoons of butter and put a teaspoonful in the bottom of each cup. Fill each cup about ⅓ to ½ full with batter and bake. After 15 minutes, drop the temperature to 350°F / 180°C and continue baking until the outside is set and golden-dark brown, about another 20 minutes.

Serve at once with jam and butter.

Notes

- *If you have a real sweet tooth (or kids) try adding sugar and cinnamon, or butter and maple syrup.*
- *Don't peek while these are baking! Opening the oven door will drop the air temperature, causing the popovers to drop in temperature and lose some of the water vapor that's critical to their rise.*
- *Curious how the choice of flour affects the inside and crust of the popover? Try making two batches, one with low-gluten flour and the second with a higher-gluten flour. Fill half the cups with one batter and the other half with the second batter. Bake them at the same time and see what happens!*

The hollow interior of popovers makes them perfect vessels for butter and jam.